THURSDAY, DECEMBER 2, 1880

POLITICAL ECONOMY

Guide to the Study of Political Economy. By Dr. Luigi Cossa, Professor of Political Economy in the University of Pavia. Translated from the second Italian edition. With a Preface by W. Stanley Jevons, F.R.S. (London: Macmillan and Co., 1880.)

THE translator of Prof. Cossa's "Guide" has conferred a great boon upon the English student of political economy. The present condition of economic science generally, and especially in this country, cannot be regarded as satisfactory. The doctrines once regarded as firmly established, and the limits of discussion apparently viewed as fixed by the nature of the facts, have been subjected to criticism from the most varied grounds, and the process of disintegration, not yet completed, has not led to any general agreement with respect to the scope and principles of the science. The system of political economy, which with some justice we designate as the English, has been revised or attacked on two grounds mainly. In the first place, the fundamental notions upon which it proceeded have been criticised as too narrow and limited, as referring solely to one economic condition and as leading to results of an abstract and isolated character. The "Economic Studies" of the late Mr. Bagehot represent fairly this phase of opinion, while the excellent little compendium by Prof. and Mrs. Marshall, the "Economics of Industry," is a specimen of the mode in which the older theorems require to be restated in the light of more general principles. In the second place, the great advance in what we may call social science, and the application of the historic method to the study of the various orders of social facts, have led, on the part of many modern writers, to an almost total rejection of the whole system of doctrines grouped together under the title of Political Economy. The fundamental principles, the methods of reasoning from them, and the conclusions arrived at, have all been questioned, while a perfectly chaotic state of opinion appears to exist regarding the nature and method of that which is to take the place of the formerly accepted doctrine.

The present work supplies most timely aid in the discussion of these complicated problems. The first part (pp. 1-84), which treats in a thoughtful and judicious manner the province of political economy, its method, and its bearing upon social facts generally, brings into due prominence the immense extent and variety of the inquiries which, in an unsystematic fashion, have come to be included in one body of doctrine, and fairly warrants the conclusion that in future we must regard political economy as a complex of different sciences, with distinct aims and requiring distinct methods of treatment. The second part (pp. 85-227), containing a brief sketch of the history of the science, which we may without hesitation pronounce as unrivalled of its kind, leads by another path to the same result. The English student will learn from this history of the development of the science, more especially from the admirable account of recent German and Italian works, the nature of the various general principles which have been accepted as furnishing the foundation of economics and its allied branches, and will be enabled to discover in what respects mainly the peculiar doctrines of the older system require revision and amendment.

Prof. Cossa would doubtless be the first to admit that the brief treatment here given of so complex a problem as the determination of the province and logical character of political economy cannot be expected to furnish a final solution. His remarks on the essential nature of pure or theoretical political economy, which he regards as the science of the *social* laws of wealth, are at least instructive and helpful, while the sections on the relation of economics to the various branches of legislative science leave little to be desired. At the same time it may be doubted whether there is really any place for the art of political economy here alluded to, and it may be questioned whether the mode the author adopts for separating economics from technology on the one hand, and from economic legislation on the other, is satisfactory in itself, or so clear as what we find, *e.g.*, in Hermann and Wagner. The chapter on Method in Political Economy contains little more than a judicious reproduction of Cairnes' well-known essay, and the remarks on the historical method, though acute and sensible, do not seem to us to go to the root of the matter.

The historical sketch, the main feature of the work, deserves every praise that can be given for breadth and exactitude of knowledge, for fairness and acuteness of criticism. Particularly valuable are the sections on the Political Economy of the Greeks and Romans, and on the Physiocratic school. One recognises with satisfaction the cordial appreciation extended by the author to certain great works of modern Continental economists which are scarcely known, even by name, in this country, but which must be pronounced absolutely indispensable to the student. Such *e.g.* are v. Hermann's "Staatswirthschaftliche Untersuchungen," the first section of which is certainly the best treatment of the fundamental notions of pure economics, v. Mangoldt's "Volkswirthschaftslehre," Knies' "Geld und Credit," Courcelle-Seneuil's "Traité," and Cherbuliez' "Précis." As text-books of the subject, v. Mangoldt's "Grundriss" and Cherbuliez' "Précis" are unsurpassed.

Naturally one cannot always assent to the critical opinions expressed on detached doctrines or authors. Thus it seems to us that the author ought not to have included Codillac without further mention as a follower of Quesnay; that his estimate of the merits of Storch's "Cours" is much too low; that he is hardly fair to von Thünen's acute speculations on interest and wages; and that he is quite mistaken regarding the nature of v. Mangoldt's theory of profit. What Prof. Cossa, in this connection, stigmatises as "an equivocation" (p. 200) is in fact a misunderstanding of his own.

In a brief sketch covering so wide a literature as that of political economy, absolute completeness is not to be expected, and probably the author has good reasons for omitting various names which occur to one as having a place in the history of the science. Still one is surprised to find a studious omission of the whole school of economical writers to which the vague term *socialist* has been applied. Proudhon, we think, is mentioned once; Fourier, St. Simon, and Karl Marx are not mentioned at all. So

too, American writers are dismissed without notice, save a passing allusion to F. A. Walker. Carey's theories are occasionally referred to in connection with other names, but no specific account is given of them, nor are other American authors, orthodox or heterodox, better treated. Even a general history ought not, one would think, to have omitted notice of such writers as Lord Lauderdale (whose treatment of Demand and of the Functions of Capital has not received the attention it deserves), R. Jones (whose essay on the Early English Economists might also have been noted in its proper place), Jacob, Stirling (the translator of Bastiat and author of an excellent but well-nigh forgotten work, "Philosophy of Commerce"), Bernhardi (the author of a remarkable treatise on Large and Small Landed Properties), Hübner, H. Thornton, Baumstark, Skarbek, Cieskowski, Saint-Chamans, Esmenard de Mazet, Louis Say, Schön, Canard, and Cazeaux. Dureau de la Malle's work might have been noted in connection with the political economy of the Romans, and De Tracy's name should not have passed without reference to his commentary on Montesquieu.

The translation appears to us generally excellent, and the translator, who is evidently well acquainted with the subject, deserves much credit for the clear and concise English into which she has rendered Prof. Cossa's work.

OUR BOOK SHELF

Avis préliminaire d'une nouvelle Classification de la Famille des Dytiscidæ. Par D. Sharp. (Extrait des *Comptes rendus* de la Société Entomologique de Belgique, Séance du 4 septembre, 1880.)

DR. SHARP is well known to have been long occupied on a work on the water-beetles of the world (at any rate on those of this particular family). The author announces it as ready for the press, and has forwarded to the Belgian Entomological Society a sketch of his ideas of the limits of the family and its classification, from which we learn that about 80 genera are recognised. One of the most important characters, as separating true *Dytiscidæ* from *Carabidæ* and from all other *Coleoptera*, appears to consist of the condition of the metathoracic episternum in connection with the intermediate cotyloid cavities. The family as a whole is divided into two great divisions, termed "*fragmentati*", and "*complicati*," the latter being headed by the anomalous genus *Amphizoa*, the position assigned to which will perhaps not find universal favour. No one can doubt that the book, when it appears, will mark an era in this department of entomology. It is a great pity therefore that Dr. Sharp should throw himself open to the shafts of ridicule in his choice of terms wherewith to designate some of his new genera. We need only allude here to such terms as *Huxelhydrus* (presumably a misprint for *Huxleyhydrus*), *Darwinhydrus*, and *Tyndalhydrus* ! ! ! We all revere the honoured names that form the prefixes, and fail to realise the watery connection suggested; if we mistake not, the bearers of them are not disciples of Sir Wilfrid Lawson.

Aid to the Identification of Insects. Edited by Charle Owen Waterhouse. Lithographs by Edwin Wilson. Small 4to, Part I. (London: E. W. Janson, 35, Little Russell Street, W.C.)

MR. WATERHOUSE, whose duties in the zoological department of the British Museum have probably continually caused him to feel the want of some such work as that which he now commences under the above title, has conceived the idea of issuing, at intervals of a month or six weeks, a series of hand-coloured drawings of insects of all orders not previously figured. Every working naturalist knows that a good pictorial representation conveys a more accurate and ready perception of a species than the most elaborate verbal description; and we can imagine no more ready way of widely disseminating a knowledge of the arcana of science than this. Each part is to contain eight or nine plates, each representing a single species, with its generic and specific names, the name of its describer, and a reference to its locality and place of description. The plates can be classified on the completion of a volume (twelve parts), when a title-page and index will be issued.

The first part, just issued, contains some well-executed figures of *Coleoptera*, *Hemiptera*, and *Lepidoptera*. The whole idea is unconsciously a repetition of Prof. McCoy's "Prodromus of the Zoology of Victoria," but with no Government money to back it up.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Geological Climates

I HAVE read with much interest Mr. Starkie Gardner's letter in NATURE, vol. xxiii. p. 53.

It is not necessary for me to discuss the question whether I am right in requiring an increase of 20° F. mean annual temperature at Bournemouth in Eocene times, or whether he is right in demanding an increase of only 14° F. to 15°, for I am able to show that the one increase is as *impossible* as the other, on the principles held by Lyell and his followers.

Mr. Starkie Gardner's ideas on the subject of oceanic circulation and its effects upon climate are expressed in the following words:—

"The general cooling effect of incessant oceanic circulation between the North Pole and the Tropics is, I think, scarcely taken into sufficient account; and although it may be contended that conversely the northerly flow of the Gulf Stream mitigates climate, I think that its action in Europe is chiefly in fending off the ice-laden currents from our coasts," &c., &c.

This statement, to my mind, involves so complete a misapprehension not only of the physical causes of oceanic circulation, but also of the whole problem of geological climate, that I shall ask your permission to lay down a few elementary propositions on the subject, which are capable of demonstration.

1. The Gulf Stream of the North Atlantic, so far from acting the part of a policeman in "fending off" imaginary cold water streams from the Polar regions, is the *cause of their existence*. If there were no Gulf Stream there could be no Labrador current of cold water running south. The same statement is true of the Kuro-Siwo of the North Pacific, of the Brazilian current of the South Atlantic, and of the Mozambique curren of the Indian Ocean.

2. If the globe were covered with water, or in the condition of an archipelago pretty uniformly distributed, there would be no exchange of currents between the Tropics and the Poles, and consequently no effect upon climate. Within the Tropics there would be a broad, slow current of warm water moving from east to west, and producing no effect upon climate. In the temperate zones there would be in the northern hemisphere a feeble interchange of south-westerly and north-easterly currents, and in the southern hemisphere a similar interchange of north-westerly and south-easterly currents, both incapable of affecting climate to any sensible degree.

3. If a north and south barrier be constructed to the westward of a locality like the West of Europe; such a barrier as North and South America affords, a gulf stream is, at once, formed, and a corresponding Labrador current running in the opposite direction.[1] The effect of the Gulf Stream is to raise the temperature of the West of Europe to its *maximum*, and the effect of the Labrador current is to depress the temperature of the east coast of North America to its *minimum*.

4. It is *impossible* to suggest any rearrangement of land and water which shall sensibly *raise the temperature of the West of*

[1] The earth's rotation compels the Gulf Stream to impinge on the west coast of Europe, and the Polar current on the east coast of North America.

Europe, or sensibly *depress the temperature of the east of North America*.

Mr. Gardner makes the following hypothetical redistribution of land and water :—

"Supposing, as all evidence tends to prove,[1] that Northern Europe and America were connected by continuous land in Eocene time, would not the mere fact of shutting off the Arctic seas cause a general and perhaps sufficient rise of temperature?"

My answer to this is that such an arrangement of land and water in the North Atlantic would raise considerably the present *minimum* temperature of the east coast of North America, but would produce little or no effect in raising the already *maximum* temperature of West Europe, which already receives the full benefit of the Gulf Stream, and suffers none of the injuries of the Labrador current.

It seems to me not possible to raise the mean annual temperature of Bournemouth 15° F. or 20° F. without supposing an *increased Gulf Stream*; in other words, an *an increased sun-heat*, which is contrary to the ideas of Lyell and his followers.

I must again ask Mr. Duncan to name the *species* of bamboo that flourishes so luxuriantly at Cooper's Hill under the disadvantageous conditions he has so well described.

If he decline to do so I have no other remedy than to go to the Indian Engineering College on my next visit to London, and inspect and report on the bamboo myself.

Trin. Coll. Dub., November 23 SAML. HAUGHTON

"Sulphuric Acid and Alkali"

MR. MACTEAR informs me that the statements contained in my review of Prof. Lunge's second volume, which appeared in your columns last week, require amendment, and I beg, in justice to Mr. Mactear, to make the following remarks :—

1. It appears that the direct object of Mr. Mactear's process is to reduce the amount of limestone to the least possible amount. Hence the words "in excess of that usually worked" are to be omitted in the sentence referring to this subject.

2. With regard to the statement that many thousands of pounds have been gained in a single works by the adoption of Mr. Mactear's process, that gentleman has placed in my hands the proof that this fact is correct.

There remains however no doubt that, in the Lancashire district at least, the liming process is not now so generally adopted as Dr. Lunge implies; but this may be explained by the fact that Mactear's process greatly reduces the quantity of caustic soda, and this does not suit the Lancashire plan of working. H. E. ROSCOE

A General Theorem in Kinematics

PROF. MINCHIN has been anticipated in his discovery of the theorem on uniplanar motion given in NATURE, vol. xxiii. p. 62. It was published some six years ago by Prof. W. Schell of the Polytechnikum, Carlsruhe, in the *Zeitschrift für Mathematik und Physik*, xix. 3. The paper containing it is entitled "Ueber den Beschleunigung zustand des ebenen unveränderlichen, in der Ebene beweglichen Systems," and commences at p. 185. The two parts of the theorem will be found in leaded type at pp. 190 and 192. The paper (which is an admirable specimen of clear writing) is purely kinematical, and treats only of motion *in plano*. The dynamical consequences pointed out by Prof. Minchin are accordingly not to be found in it; nor the analogous theorem for the general motion of a rigid body obtained by Prof. Wolstenholme. The following quaternion proof of the latter theorem may interest some of your readers.

The velocity $\dot\rho$ of the particle at vector distance ρ from a fixed origin is—

$$\dot\rho = \alpha + V\beta\rho,$$

α being the velocity at the origin, and β the angular velocity.

The acceleration is therefore—

$$\ddot\rho = \dot\alpha + V\dot\beta\rho + V\beta(\alpha + V\beta\rho),$$

and will be zero for one definite value of ρ.

Taking the point of no acceleration for origin, the constant terms in the expression for the acceleration must vanish, and the expression will be reduced to—

$$\ddot\rho = V\dot\beta\rho + V\beta V\beta\rho,$$

which is identical with Prof. Wolstenholme's result.

Malone Road, Belfast, November 22 J. D. EVERETT

Phosphorescent Centipedes

ON September 28 last I was walking in my garden here at eight o'clock in the evening with a friend, when we were simultaneously attracted by a bright light about twenty paces in front of us. The light was so bright that in the distance it looked like moonlight through the trees; and had the moon been shining we should probably not again have thought about the light until we came upon it. But it was a dark night, though warm and even sultry, and still. The light was so bright that, taking a letter out of my pocket, I could read it. It resembled an electric light, and proceeded from the bodies of two centipedes and their two trails. The centipedes were about four inches apart. The light illumined the entire body of the animal, and seemed to increase its diameter three times. It flashed along both sides of the creature in sections; there being about six sections from head to tail, between which the light played. The light behaved precisely like the electric light, moving as it were perpetually in two streams, one on each side, and yet lighting up the whole body. In the trail there was no movement, but light only. The trail extended 1½ foot from each centipede over the grass and the gravel-walk, and it had the appearance of illuminated mucus.

Having observed these creatures for several minutes, I picked one of them up and lodged it in a box which had been procured from the house, for further observation. On touching the centipede the light in both animals, as well as in both trails, was instantly extinguished. Later in the evening we found another centipede, and this also emitted light in the same manner, both from body and trail as I have described. My gardener then informed me that he had observed these creatures during the previous three or four evenings, both in the garden and in the stableyard.

On the following day I took the centipede to Prof. Flower, who, with the assistance of the authorities of the British Museum, has identified the species as *Geophilus subterraneus*.

The published descriptions of the luminous properties of the British centipedes differ considerably from what I observed in this instance.

The best, so far as I know, is given in Shaw's "General Zoology," vol. vi. After describing the animal, it proceeds thus: "It is possessed of a high degree of phosphoric splendour, which, however, seems to be only excited when the animal is pressed or suddenly disturbed, when it diffuses a beautiful smaragdine light, so powerful as not to be obliterated by the light of two candles on the same table."

I may observe that I was never able to induce my centipede to shine whilst in captivity. It may also be worthy of note that the atmosphere was exceptionally dry and the barometer remarkably high at the time of the observation.

B. E. BRODHURST

Grange Court, Chigwell, November 22

The Yang-tse, the Yellow River, and the Pei-ho.

ALTHOUGH the conclusions at which Dr. Woeikof has arrived (NATURE, vol. xxiii. p. 9) with regard to my estimations of the discharge of water and sediment of the Yang-tse and Pei-ho may militate against their being accepted as generally typical of these two rivers, I would urge that another series of observations would be of more service in either correcting or in corroborating my estimations.

In the case of the Yang-tse it will have been seen that, according to the estimate of Capt. Blakiston at I-chang and of my own at Hankow—500,000 and 650,000 cubic feet of water per second respectively,—this river increases its discharge by 150,000 cubic feet in the 360 miles that intervene between these two places of observation. In this portion of its course the Yang-tse not only receives the waters of the Han, but is also the recipient of those of the Tung-ting Lake; and the increase it receives from these two important tributaries—an amount exceeding the water-discharge of the Nile[1]—is not such as would support the conclusion that my estimate for the Yang-tse at Hankow is under the usual average.

My observations on the Pei-ho, referring as they do to only a portion of the year, are more open to correction; and a series of observations throughout the entire twelve months are certainly to be preferred.

In conclusion I may state that, although my various estimations are open to criticism, my object will have been gained if, by inviting further inquiry into the hydrological features of the great river system of China, an accurate knowledge of them is obtained. H. B. GUPPY

[1] I entirely deny this, but will not now turn aside from my present purpose to discuss it.

[1] 130,000 cubic feet per second.

Aurora observed at Ovoca, Co. Wicklow, November 3.—Observations from 5.30 p.m. to Midnight

At 5.30 p.m. yellow lights tinged with red were coming up all round the horizon; these at intervals formed indistinct columns to the south-west and north-west. At 6.30 there were faint reddish lights forming fans at different points; these were succeeded by red and orange lights that rose forming glows, columns, and pencils; while at 7.30 a bright silver-white arch appeared to the north—the horns from this arch were pencils of white, which seemed to cross the arch; they were very numerous, appearing and disappearing nearly instantaneously; from about four to seven appeared at one time. Some of them were very long, shooting up to the zenith. After the arch had dissolved away, brilliant narrow, well-defined, thin columns of silver light shot up, the most marked coming up to the north-west at 7.40; this darted up suddenly, and moved gradually southward, and when about due west, close to the church tower, it disappeared at 7.45.

These silver lights solely occurred between the west and north-east, while all round the horizon red and orange lights were rising; these sometimes congregated at the zenith in a mass. At 7.50 two brilliant silver pencils rose to the north-north-east, but disappeared nearly instantaneously.

From 8 p.m. to 8.50 there were orange and red glows of light sometimes in indistinct columns; but at the latter hour there appeared to the north-west a vivid display of silver light that lasted about five minutes; this was succeeded by a deep orange cloud that travelled up to the zenith. From 9 to 10.30 there was an orange to red glow round the horizon, while at intervals from the north-west rose pencils of silver light, five very brilliant ones rising at 10.30. They were succeeded by a bright silver glow over the whole of the western heaven, across which at intervals passed glows of red and orange light; columns also rose, while at times horizontal streaks of brilliant silver lights appeared and disappeared in a flash. At 11 there was an orange glow round the horizon; this, with spurts of light coming up between the south-west and north-east, were all that was observed up to midnight.

G. H. KINAHAN

MR. SPENCER AND PROF. TAIT

WHEN, in NATURE for July 17th, 1879, while reviewing Sir Edmund Beckett's book, Prof. Tait lugged in Mr. Kirkman's travesty of the definition of Evolution, most readers probably failed to see why he made this not very relevant quotation. But those who remembered a controversy which occurred some years previously, possibly divined the feeling which prompted him thus to go out of his way.

At the time I said nothing; but having recently had to prepare a new edition of "First Principles," and thinking it well to take some notice of books, and parts of books, that have been written in refutation of that work, I decided to deal also with Mr. Kirkman's implied criticism, in which Prof. Tait so heartily concurred; and by way of gauging Prof. Tait's judgment on this matter, I thought it not amiss to give some samples of his judgment on matters falling within his own department. To make it accessible to those possessing previous editions of "First Principles," the Appendix containing these replies to critics was published as a pamphlet.

In the inaugural lecture of this session, recently given to his students, part of which is published in the last number of NATURE, Prof. Tait first of all recalls a passage from the preceding controversy. From this he quotes, or rather describes, a clause which, standing by itself, appears sufficiently absurd; and he marks the absurdity by a double note of admiration. Whether when taken with its context it is absurd, the reader will be able to judge on reading the passage to which it belongs.

In disproof of certain conclusions of mine, there had been quoted against me the *dictum* of Prof. Tait concerning the laws of motion, which is that—"as the properties of matter might have been such as to render a totally different set of laws axiomatic, these laws must be considered as resting on convictions drawn from observation and experiment and not on intuitive perception." Not urging minor objections to this *dictum*, I went on to say:—"It will suffice if I examine the nature of this proposition that 'the properties of matter *might have been*' other than they are. Does it express an experimentally-ascertained truth? If so, I invite Prof. Tait to describe the experiments? Is it an intuition? If so, then along with doubt of an intuitive belief concerning things *as they are*, there goes confidence in an intuitive belief concerning things *as they are not*. Is it an hypothesis? If so, the implication is that a cognition of which the negation is inconceivable (for an axiom is such) may be discredited by inference from that which is not a cognition at all, but simply a supposition. . . . I shall take it as unquestionable that nothing concluded can have a warrant higher than that from which it is concluded, though it may have a lower. Now the elements of the proposition before us are these:—*As* 'the properties of matter might have been such as to render a totally different set of laws axiomatic' [*therefore*] 'these laws [now in force] must be considered as resting . . . not on intuitive perception:' that is, the intuitions in which these laws are recognised, must not be held authoritative. Here the cognition posited as premiss, is that the properties of matter might have been other than they are; and the conclusion is that our intuitions relative to existing properties are uncertain. Hence, if this conclusion is valid, it is valid because the cognition or intuition respecting what might have been, is more trustworthy than the cognition or intuition respecting what is!"

From which it is manifest that, when asking (of course ironically) whether this alleged truth was an experimentally-ascertained one, my purpose was partly to ennumerate and test all imaginable suppositions respecting the nature of Prof. Tait's proposition, and partly to show that he had affirmed something concerning the properties of matter which cannot be experimentally verified, and therefore which, by his own showing, he has no right to affirm.

The first example which, in my recent replies to criticisms, I have given of Prof. Tait's way of thinking, is disclosed by a comparison of his views concerning our knowledge of the universe as visible to us, and our knowledge of an alleged invisible universe. This comparison shows that:—

"He thinks that while no validity can be claimed for our judgments respecting perceived forces, save as experimentally justified, some validity can be claimed for our judgments respecting unperceived forces, where no experimental justification is possible."

Part of Prof. Tait's answer is that "the theory there developed [in the "Unseen Universe"] was not put forward as probable, its purpose was attained when it was shown to be conceivable." To which I rejoin that whereas Prof. Tait said he found in this theory a support for certain theological beliefs, he now confesses that he found none; for if no probability is alleged, no support can be derived. The other part of his answer concerns the main issue. After pointing out that the argument of this work, "carried on in pursuance of physical laws established by converse with the universe we know, extends them to the universe we do not know," I had urged that if we have "no warrant for asserting a physical axiom save as a generalisation of results of experiments—if, consequently, where no observation or experiment is possible, reasoning after physical methods can have no place; then there can be no basis for any conclusion respecting the physical relations of the seen and the unseen universes," "since, by the definition of it, one term of the relation is absent." Prof. Tait's explanation is extremely startling. When following the discussion in the "Unseen Universe," throughout which the law of the Conservation of Energy and the Principle of Continuity are extended from the tangible and visible matter and motion around us to an

unknown form of existence with which they are supposed to be connected, readers little thought that Prof Tait meant by this unknown form of existence his own mind. Yet this is all that he now names as the missing term of the relation between the seen universe and the unseen universe.

The second sample which I gave of Prof. Tait's views on matters pertaining to his own subject, concerned the nature of inertia, which he describes by implication as a positive force. Here I quoted Prof. Clerk Maxwell. To repeat his criticism in full would cause me to trespass on the pages of NATURE even more unduly than I must do. If, however, any reader turns to NATURE, July 3rd, 1879, and reads the passage in question, he will be able to judge whether it is, or is not, a joke, and if a joke, at whose expense. Meanwhile, the essential question remains. Prof. Tait says that matter has "an innate power of resisting external influences." I, contrariwise, say that the assertion of such a power is at variance with established physical principles.

One further illustration of Prof. Tait's way of thinking was added. Quoting from a lecture given by him at Glasgow, for the purpose of dispelling "the widespread ignorance as to some of the most important elementary principles of physics," I compared two different definitions of force it contained. In a passage from Newton, emphatically approved by Prof. Tait, force is implied to be that which changes the state of a body, or, in modern language, does work upon it. Later on in the lecture, Prof. Tait says—"force is the rate at which an agent does work per unit of length." I contended that these definitions are irreconcilable with one another; and I do not see that Prof. Tait has done anything to reconcile them. True, he has given us some mathematics, by which he considers the reconciliation to be effected; and, possibly, some readers, awed by his equations, and forgetting that in symbolic operations, carried on no matter how rigourously, the worth of what comes out depends wholly on what is put in, will suppose that Prof. Tait must be right. If, however, his mathematics prove that while force is an agent which does work, it is also the rate at which an agent does work, then I say—so much the worse for his mathematics.

From these several tests of Prof. Tait's judgment, in respect to which I fail to see that he has disposed of my allegations, I pass now to his implied judgment on the formula, or definition, of Evolution. And here I have first to ask him some questions. He says that because he has used the word "definition" instead of "formula," he has incurred my "sore displeasure and grave censure." In what place have I expressed or implied displeasure or censure in relation to this substitution of terms? Alleging that I have an obvious motive for calling it a "formula," he says I am "indignant at its being called a *definition*." I wish to see the words in which I have expressed my indignation; and shall be glad if Prof. Tait will quote them. He says—"It seems I should have called him the *discoverer of the formula!*" instead of "the inventor of the definition." Will he oblige me by pointing out where I have used either the one phrase or the other? These assertions of Prof. Tait are to me utterly incomprehensible. I have nowhere either said or implied any of the things which he here specifies. So far am I from consciously preferring one of these words to the other, that, until I read this passage in Prof. Tait's lecture, I did not even know that I was in the habit of saying "formula" rather than "definition." The whole of these statements are fictions, pure and absolute.

My intentional use of the one word rather than the other, is alleged by him *à propos* of an incidental comparison I have made. To a critic who had said that the formula or definition of Evolution "seems at best rather the blank form for a universe than anything corresponding to the actual world about us," I had replied that it might similarly be "remarked that the formula—'bodies attract one another directly as their masses and inversely as the squares of their distances,' was at best but a blank form for solar systems and sidereal clusters." Whereupon Prof. Tait assumes that I put the "Formula of Evolution alongside of the Law of Gravitation," in respect to the definiteness of the previsions they severally enable us to make; and he proceeds to twit me with inability to predict what will be the condition of Europe four years hence, as astronomers "predict the positions of known celestial bodies four years beforehand." Here we have another example of Prof. Tait's peculiarity of thought. Because two abstract generalisations are compared as both being utterly unlike the groups of concrete facts interpreted by them, *therefore* they are compared in respect to their other characters.

But now I am not unwilling to deal with the contrast Prof. Tait draws; and am prepared to show that when the conditions are analogous, the contrast disappears. It seems strange that I should have to point out to a scientific man in his position, that an alleged law may be perfectly true, and that yet, where the elements of a problem to be dealt with under it are numerous, no specific deduction can be drawn. Does not Prof. Tait from time to time teach his students that in proportion as the number of factors concerned in the production of any phenomenon becomes great, and also in proportion as those factors admit of less exact measurement, any prediction made concerning the phenomenon becomes less definite; and that where the factors are multitudinous and not measurable, nothing but some general result can be foreseen, and often not even that? Prof. Tait ignores the fact that the positions of planets and satellites admit of definite prevision, only because the forces which appreciably affect them are few; and he ignores the fact that where further such forces, not easily measured, come into play, the previsions are imperfect and often wholly wrong, as in the case of comets; and he ignores the fact that where the number of bodies affecting one another by mutual gravitation is great, no definite prevision of their positions is possible. If Prof. Tait were living in one of the globular star-clusters, does he think that after observations duly taken, calculations based on the law of gravitation would enable him to predict the positions of the component stars four years hence? By an intelligence immeasurably transcending the human, with a mathematics to match, such prevision would doubtless be possible; but considered from the human standpoint, the law of gravitation, even when uncomplicated by other laws, can yield under such conditions only general and not special results. And if Prof. Tait will deign to look into "First Principles," which he apparently prides himself on not having done, he will there find a sufficient number of illustrations showing that not only other orders of changes, but even social changes, are predictable in respect to their general, if not in respect to their special, characters.

There remains only to notice the opinion which Prof. Tait seems still to hold, that the verbal transformation which Mr. Kirkman has made in the formula or definition of Evolution, suffices to show its hollowness. Here I may be excused for repeating what I have already said elsewhere, namely, that "We may conveniently observe the nature of Mr. Kirkman's belief, by listening to an imaginary addition to that address before the Literary and Philosophical Society of Liverpool, in which he first set forth the leading ideas of his volume; and we may fitly, in this imaginary addition, adopt the manner in which he delights.

"Observe, gentlemen," we may suppose him saying, "I have here the yolk of an egg. The evolutionists, using their jargon, say that one of its characters is 'homogeneity'; and if you do not examine your thoughts, perhaps you may think that the word conveys some idea. But now if I translate it into plain English, and say that

one of the characters of this yolk is 'all-alikeness,' you at once perceive how nonsensical is their statement. You see that the substance of the yolk is not all-alike, and that therefore all-alikeness cannot be one of its attributes. Similarly with the other pretentious term 'heterogeneity,' which, according to them, describes the state things are brought to by what they call evolution. It is mere empty sound, as is manifest if I do but transform it, as I did the other, and say instead 'not-all-alikeness.' For on showing you this chick into which the yolk of the egg turns, you will see that 'not-all-alikeness' is a character which cannot be claimed for it. How can any one say that the parts of the chick are not-all-alike? Again, in their blatant language we are told that evolution is carried on by continuous 'differentiations'; and they would have us believe that this word expresses some fact. But if we put instead of it 'somethingelseifications' the delusion they try to practise on us becomes clear. How can they say that while the parts have been forming themselves the heart has been becoming something else than the stomach, and the leg something else than the wing, and the head something else than the tail? The like manifestly happens when for 'integrations' we read 'sticktogetherations': what sense the term might seem to have, becomes obvious nonsense when the substituted word is used. For nobody dares assert that the parts of the chick stick together any more than do the parts of the yolk. I need hardly show you that now when I take a portion of the yolk between my fingers and pull, and now when I take any part of the chick, as the leg, and pull, the first resists just as much as the last—the last does not stick together any more than the first; so that there has been no progress in 'stick-togetherations.' And thus, gentlemen, you perceive that these big words which, to the disgrace of the Royal Society, appear even in papers published by it, are mere empty bladders which these would-be philosophers use to buoy up their ridiculous doctrines."

But though it is here, I think, made apparent enough that even when disguised in Mr. Kirkman's grotesque words, the definition of Evolution continues truly to express the facts, Prof. Tait shows no sign of changing his original opinion that Mr. Kirkman has made "an exquisite translation" of the definition. Nay, so charmed does he appear to be with Mr. Kirkman's feats of this nature, that he gives us another of them. One of two conclusions must be drawn. Prof. Tait either thinks that fallacies are disclosed by the aid of these cacophonous long words, or else the clatter of curious syllabic compounds greatly excites his sense of humour. In the last case we may infer that had he been one of that "Twelfth Night" party in which the Clown exclaims—"I did impeticos thy gratillity," he would have joined in Sir Andrew Ague-cheek's applause. HERBERT SPENCER

NOTES ON THE GEOLOGY OF EAST-CENTRAL AFRICA

THOUGH many travellers have now penetrated almost every part of Central Africa, and described the main geographical features, yet their accounts have been singularly barren in any reliable geological details. The Geographical Society, in its late expedition to the lake region, sought to remedy this want, and I, as a student of that science, had the honour of being selected as geologist and assistant to Mr. Keith Johnston, the leader of the expedition.

After the lamentable death of Mr. Johnston, almost at the commencement of our journey, the entire work of the expedition fell into my inexperienced hands, and to perform that work conscientiously precluded all hope of anything but the most superficial geological research. The difficulties in the way were, as in all tropical countries, much increased by the luxuriance of the vegetation, which seldom leaves a rock uncovered and exposed to view. Notwithstanding these obstacles to geological investigation, however, glimpses of the internal structure of the country traversed were here and there obtained, which I think may fairly be considered as shadowing forth the main general features of the geology of the Great Lake Region.

Let me briefly point these out in the order of their occurrence along our route to Nyassa and Tanganyika. The comparatively unbroken stretch of low-lying country which so markedly borders the East Coast of Africa is formed of two, if not three, raised beaches, elevated in recent times above the sea. They consist chiefly of brick-red sands and clays overlying coral rock. The former have been derived by denudation from the coast ranges, which, consisting of hornblende rocks and others containing a large amount of iron, easily account for the deep-red colour characterising these deposits. The sands are of value as containing the gum copal, of which our best varnishes are made. As the tree from which this gum has been derived is now almost extinct, it would seem that a considerable lapse of time has occurred since these deposits have been formed; but geologically they must be recent, as among the many insects that have been found imbedded in the copal none, as far as I am aware, are extinct. The Msandarusi, or gum copal tree, has evidently been restricted to the sea-coast, as neither it nor the gum has ever been found as yet in the interior.

In passing from these sands and clays we step over an immense gap in the geological record, of which no trace remains, as the rocks we next reach are evidently of carboniferous age. These occupy a variable strip along the base of the mountains, here and there rising into small hills and ranges.

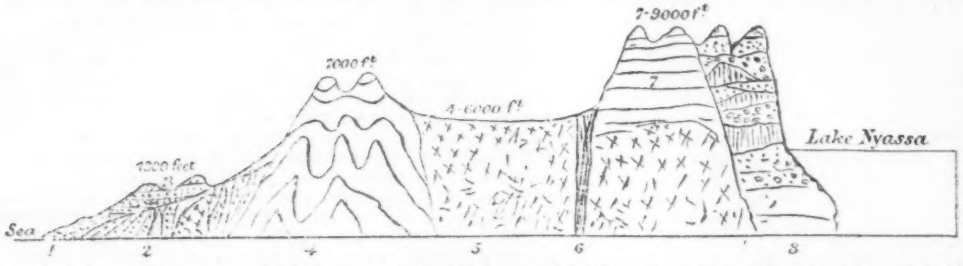
They are found stretching from at least Mozambique to the Equator. On the Rovuma coal-beds are found. In the Rufigi valley there are red liver-coloured sandstones with pebbled beds and with interbedded lavas which in one curiously-shaped mountain near Behobeho produce a remarkable step-like appearance. These beds are horizontal, but beneath them are sandstones tilted by the intrusion of eruptive basalts, producing an unconformability which however is probably only local. Further north on the Unyanyembe road from Bogamoyo, and at the base of the mountain I observed on my return march compact beds of fossiliferous limestones, together with shales, &c.

At Umba, a place north of Pangani, I also discovered limestone, which I believe is now being burnt by the Universities Mission Agents. The young geologist, Thornton, the companion of Baron von der Decken, observed this same formation around Mombas, which he noted as being exactly similar to the coal formation of the Zambesi. As no rocks of a later date have been found along the whole of the east coast from Mozambique to the Equator, we may safely infer that this part of the continent has been above water since Carboniferous times, and this inference is strengthened by natural history evidence.

We have now reached the base of the mountains, and again we are brought face to face with another great break in the series of events. From the Carboniferous sandstones and limestones we pass abruptly to highly metamorphosed rocks whose exact place in the geological series is as yet extremely problematical. These consist of the schists, gneiss, and hornblende rocks which form the mountain range that flanks the great Central Plateau extending from Abyssinia to the Cape.

In crossing this range we rose to a height of 7000 feet. We found the strike of the rocks to be north and south. They present every intermediate grade of variation from the most coarsely crystalline to those with the bedding still traceable. Indeed it would be somewhat difficult to point out any sharply-defined line of demarcation between the granites, which seem to predominate

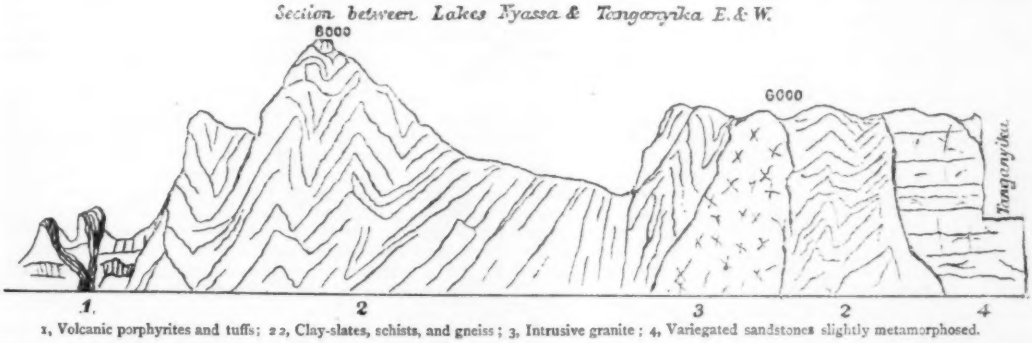
in the plateau, and the less metamorphosed rocks. It seems to me that this range suggests a line of weakness during the elevation of the continent, owing to which the neighbouring rocks were more easily folded up and raised above the line of greatest pressure, which has turned the main mass of the continent into granite. There is however some hope that more definite light will be thrown upon the question of the age of this range, as on my way back to the coast I discovered in the Usagara Mountains some much metamorphosed rocks with imperfectly pre-



Section of Rocks between Dar-es-salaam and Lake Nyassa. 1, Red sandy clays; 2, Carboniferous (?) sandstones with intrusive rocks; 3, Carboniferous sandstones with interbedded lavas; 4, Schists, gneiss, and other highly metamorphosed rocks; 5, Granite forming main mass of the interior; 6, Intrusive rocks and probable line of fault; 7, Clay slates with occasional felspathic rocks; 8, Volcanic porphyrites, tuffs, and agglomerates.

served fossils. A careful search would probably be rewarded by the discovery of fossils which would determine the age of these rocks.

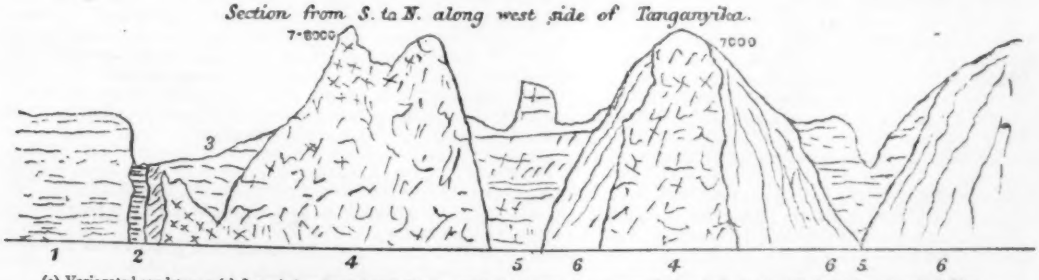
Leaving the metamorphic rocks of the flanking range, we next pass over a great stretch of granitoid rocks. This tract, extending to near the lakes, is marked by undulating hills and valleys, with wide areas comparatively level, where the Kaffir-like semi-nomadic tribes of the Wabena, Warori, Wahehi, Wagogo, and Masai herd their cattle, hunt, and live in a constant state of warfare.



1, Volcanic porphyrites and tuffs; 2 2, Clay-slates, schists, and gneiss; 3, Intrusive granite; 4, Variegated sandstones slightly metamorphosed.

The influence which the character of the country has upon the habits and manners of savage tribes is here well illustrated.

The soil formed by the degradation of this granite tract is either a stiff red clay as occurs in Ubena and Urori, sandy as in Ugogo, or grey clay as in Unyamwesi. The vegetation varies greatly according to the nature of the soil. The whole of this granitoid region is marked by the occurrence of monstrous blocks, generally rounded, and strewing the whole surface as if some great eruption



(1) Variegated sandstone; (2) Intruded rocks and probable line of fault; (3) Sandstones smashed and tilted; (4 4) Felspathic rocks; (5 5) Fine grained brick-red sandstones with quartz pebbles; (6 6 6) Greywacke and other metamorphic rocks.

had smashed the underlying rocks. Their presence, however, is not due to any such cause, the main agent having been rain and carbonic acid, assisted by rapid radiation acting along the joints and cracks.

It may be noted that at a number of points both in Ubena and Ugogo evidences of rocks erupted through the granites were obtained.

Continuing our route to Nyassa over this plateau at a general height of about 5000 feet above the sea we are confronted by a sudden rise in the ground, which forms

apparently a second and higher plateau. The abrupt change of level, together with the alteration in the internal structure and the presence of intrusive rocks at the base of the mountain seem to point to the existence of a fault of considerable magnitude, which probably is the eastward extension of a great fault to be described further on.

The rocks composing this high tract of country consist mainly of clay-slates with the original bedding still very distinct. What may be their exact relations to the granites which they probably overlie, or to the metamorphic rocks of the coast-range, we have as yet no means of ascertaining. Careful research will be required before anything definite can be said about them. The mountains cut out of these rocks by denudation are rounded in form, smooth, and by no means picturesque. They are devoid of trees, but covered with grass.

As we approach Lake Nyassa we observe evidence of much disturbance, till at a distance of about ten miles from the Lake we come upon the ancient pipe of a volcano, and five miles further on enter amongst a series of volcanic porphyrites, tuffs, and agglomerates forming mountains several thousands of feet in height, and which extend round the north end of the Lake. Along with this marked change of internal structure we have as decided a change in the scenery. The rounded mountains with smooth, grassy, and uncut sides give place to jagged peaks, serrated ridges, sharp yawning valleys, and irregular, rocky, notched sides, forming a landscape of no ordinary description.

The extraordinary series of volcanic rocks which form the magnificent mountains round the north end of Lake Nyassa probably belong to the same period as a similar series which characterise the Cape geology. The latter have been assigned to the Trias, and doubtless the immense development of volcanic rocks in Abyssinia described by Blandford is of the same age. Indeed we might almost say we have connecting links between the two places, as on my return march through Ugogo I observed evidence of volcanic outbursts, and it is well known that Kilimanjaro, further north, is of volcanic origin. It seems then that in Triassic times a great line of volcanic action stretched from the Cape by Nyassa, Ugogo, and Kilimanjaro, to Abyssinia.

But at the north-west corner of Nyassa we have evidence of later volcanic activity. In a niche cut out of the surrounding plateau and on a comparatively level plain, through which the River Jumbaka winds to the lake, a number of beautifully isolated cones rise to a height of about 300 feet. On examination these prove to be perfect volcanic craters, so entire and symmetrical as to appear almost artificial. One crater which I examined forms a beautifully bowl-shaped hollow, descending to the level of the plain, the bottom being a charming circular pond, where a number of hippopotamuses live.

It is clear from the perfect shapes of these cones, and from the fact that the surface features of the surrounding country have remained unchanged since their origin, that they must have arisen in comparatively recent times. Besides these cones there are two pretty circular lakes, which also appear to have been originally volcanic craters.

On leaving this interesting country and proceeding on our way to Tanganyika we rise once more to the top of the plateau, cross over mountains 8000 feet in height, and then descend to a general level of from 4000 to 6000 feet. We pass over clay slates and schists whose relative positions could not be determined with intrusive masses of granite. At one point an interesting section was revealed, showing the granite completely inclosing a mass of greenstone.

On nearing the south end of Lake Tanganyika we pass abruptly from these ancient rocks to red and variegated sandstones much hardened and broken, but preserving their original horizontal bedding. Rounding the end of the lake and continuing our march northward along its western side, we come to almost a sheer precipice, suddenly lowering the altitude from nearly 5000 feet to less than 3000. Running east and west along the precipice there occur intruded rocks, while on the northern or lower side of the precipice the sandstones almost disappear, being only represented by a small extent of crushed and tilted beds. Such a condition of things clearly indicates the existence of a great fault. This theory is strengthened by a similar abrupt change of rocks on the eastern side of the lake; and it will be remembered that we have already noticed among a different series of rocks still further east a sudden change of level almost on the same parallel of latitude.

The sandstones thus abruptly brought to a finish in their extension northward are succeeded by felspathic rocks which form huge mountain masses both on the east and west sides of the lake. Near the middle of the lake on its western side there occurs a curious apparently isolated area of fine red sandstones, surrounded on all sides except the east by mountains of metamorphic and felspathic rocks. These sandstones would seem to have been deposited in a small lake eight miles in diameter. Mount Malumbi, figured in Stanley's "Dark Continent," belongs to the same formation.

Still proceeding along the lake we cross a high mountain range named Tchansa, formed of metamorphic rocks with felspathic rock in the centre. We regain the sandstones once more in the country of Uguha. The sandstones here, unlike those of the south end, are very red in colour, extremely friable, and marked by the abundance of quartz pebbles. Through this formation the Lukuga River finds its way to the Congo, its course determined not by any great convulsion as some travellers have been inclined to believe, but by the long-continued action of streams wearing down the soft and friable barrier which hemmed in the lake at this point. These sandstones have an extension over a large area. They are found away towards Manyema and up the Congo Valley as far as Lake Moero, probably turning round and joining the strata we have noticed at the south end of Tanganyika. On the east side they are found from Kaboga to the north of Ujiji, though here shales are not uncommon and the strata much curved.

The absence of all fossils leaves the question of the age of these rocks in some mystery. A reference to Cape geology may, however, as in the case of the volcanic rocks, throw some light on this subject. The Tanganyika sandstones have evidently been formed in an enormous inland lake, beside which the present African lakes would look insignificant.

In Cape Colony a similar series of rocks occur of a lacustrine origin, and which have been assigned to a period not later than the Trias, and probably they belong to Palæozoic times. In the absence of anything but lithological evidence we cannot do better than place the Tanganyika sandstones in the same era as the Cape series, an era which would seem to have been emphatically characterised by the presence of great lakes.

JOSEPH THOMSON

INCANDESCENT ELECTRIC LIGHTS

THE recent experiments of Mr. J. W. Swan of Newcastle-on-Tyne have gone far towards demonstrating the practicabilty of a system of electric lighting based upon the so-called principle of incandescence. As the solution of the whole question of the possible domestic application of electric lighting depends in all probability uppon the successful application of this method, these experiments have claimed already a considerable share of public attention, though no panic has yet arisen like

that created two years ago by the far less formidable experiments of Mr. Edison in the same direction.

The material which Mr. Swan proposes to render incandescent by means of an electric current is a "wire" of prepared carbon of extraordinary density and elasticity. Twenty years ago he prepared carbon filaments for the very same purpose from calcined cardboard, inclosing them in a glass vessel from which the air was withdrawn as perfectly as the imperfect air-pumps of that date permitted. In October 1877, or one year before Mr. Edison had begun to attempt the construction of lamps with carbonised paper, Mr. Swan had some prepared carbons mounted in glass globes and exhausted by the Sprengel air-pump by Mr. Stearn of Birkenhead. This enabled Mr. Swan to discover that when the carbon was properly fixed and heated during exhaustion so that the occluded gases might be expelled, there was an end of the causes that hitherto had seemed to defeat all attempts to utilise this method of procuring an incandescent electric light; for when these conditions were observed there was none of the disintegration of the carbon rods, nor of the blackening of the globes that with less perfect vacua had proved the ruin of carbon lamps. The filaments of carbon now produced by Mr. Swan indeed resemble steel wire rather than carbon, so extraordinary is their tenacity and texture. The secret of their manufacture has not yet been made known, being the essential point of the patent rights which Mr. Swan has just secured. Each filament is about three inches long, and not more than the hundredth of an inch in diameter, and is so slight as only to weigh from one-fifteenth to one-twentieth of a grain. The durability of these filaments is remarkable. In the course of a lecture delivered on November 25 last before the Society of Telegraph Engineers, Mr. Swan stated that he had had lamps lighted continuously since August 30, with an intermission of three weeks only, and that this seemed to be far from the actual limits of durability. When the currents employed are not too strong, the lamps will last longer. The light yielded by these lamps varies, according to circumstances, from thirty to fifty standard candles. On the occasion of Mr. Swan's lecture thirty-six of these tiny lamps were exhibited working by the current of a dynamo-electric machine requiring four horse-power to drive it. In the debate which followed Mr. Swan's communication, the remarks made by Prof. Tyndall, Dr. Hopkinson, Mr. Alexander Siemens, and others, showed the real value of the advance made by Mr. Swan. The question however of the economy of the system remains yet to be decided by the practical test of durability. At a previous lecture at Newcastle-on-Tyne Mr. Swan exhibited twenty lamps fed by a current generated by a gas-engine consuming 160 cubic feet of gas per hour. The light obtained exceeded that of the seventy gas-jets which usually supplied the same room, and which consumed 280 feet per hour. Mr. Swan proposes to connect these lamps in series of fifty or a hundred in one circuit, using automatic circuit-closers to close the circuit in the rare case of the failure of a lamp. He considers his method of arranging the system to be superior to that proposed by Mr. Edison, whose method of placing the separate lamps in single branches of a divided circuit would involve the use of very heavy and costly conducting-wires without any counterbalancing advantage. With this important difference Mr. Swan's further proposal to erect central stations from which to supply currents of electricity over large areas resembles that suggested by Mr. Edison. Should the anticipations of the inventor and the present promise of the new lamps be fulfilled, domestic electric lights will certainly become a fact at no distant date.

Meantime Mr. Edison has not been idle. It is stated that he is at present laying down a service of about seven miles in length upon which to test the success or failure of his system upon a large scale. He has developed several ideas since his last appearance before public notice. He now makes his dynamo-electric generators of a much larger pattern than any heretofore attempted. He has abandoned charred cardboard in favour of a filament of carbon prepared from a cultivated variety of the Japanese bamboo. We shall hear before long whether his indomitable perseverance has been rewarded with final success. In spite of being in point of date behind Mr. Swan, he has the enormous advantages of a unique workshop and laboratory under his own direction, of a wealthy company at his back, and of the extraordinary prestige won by his previous inventions. If Mr. Swan appears to be nearer to a genuine success, Mr. Edison has a popular reputation that of itself will win a hearing for the most trivial of his inventions. Whichever of the rival systems succeeds science and mankind are the gainers. But up to the present point it seems to us that beyond question Mr. Swan is nearer the goal of practical results than his famous rival.

It may interest our readers to know that Mr. Edison's first carbon lamp is now on view along with his original phonograph and his earliest tasimeter in the Patent Museum at South Kensington.

SUBTERRANEAN FOREST IN INDIA

THE accompanying notes and illustrations on the underground forest recently discovered in excavating the Prince's Dock, Bombay, were forwarded by Col. C. J. Merriman, R.E., C.S.I., Member of the Legislative Council, and Secretary to Government (Public Works Department), Bombay.

The trees were generally found in a dark loamy soil composed of underlying rock disintegrated. The upper

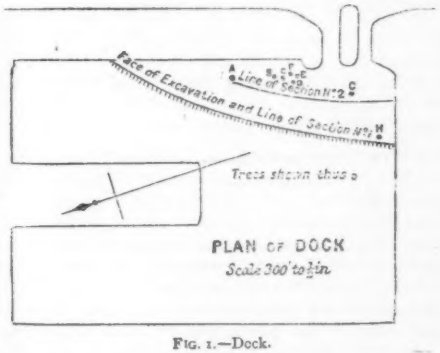


FIG. 1.—Dock.

portion of the trunks stopped at the soft black clay, which is silt. A few went a little way beyond; but as far as they protruded into the silt they were completely

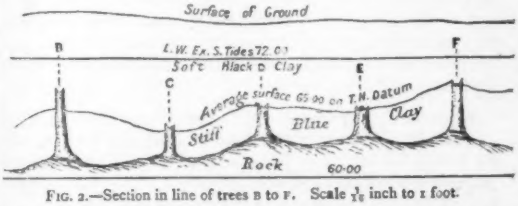


FIG. 2.—Section in line of trees B to F. Scale $\frac{1}{10}$ inch to 1 foot.

riddled by the teredo, the nearer the root the bigger the hole, showing that the boring began from the top.

The roots of the highest tree found were at 72·20 on T.H. datum, or close on Low Water extreme springs, about six feet under the surface of the mud. The lowest root was

at 55·93, or say sixteen feet under L.W. extreme springs, twenty-two feet under the surface of the mud.

Inside the dock altogether were 382 trees, 223 standing, the remainder flat. The largest tree was forty-six feet long, and 4′ 6″ girth; it was flat. None of the trees would girth over 4′ 6″. The soil in which many of them stood was only 6″ to 9″ thick over the rock. The wood is apparently black wood. The roots presented a peculiar appearance, being nearly at right angles to the trunks.

The forest seems to have stopped at the gates, as very few trees were brought up in the dredging operations.

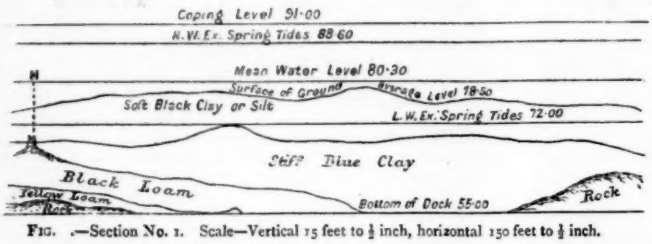
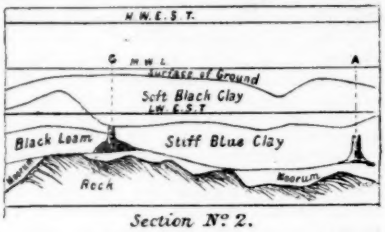


FIG. 3.—Section No. 1. Scale—Vertical 15 feet to ½ inch, horizontal 150 feet to ½ inch.



Section No 2.

FIG. 4.—Section No. 2.

The mixture of different kinds of stone is curious. In small patches we find trap, which gives way to moorum, and then a sort of pudding-stone mixed up with black and red stuff so hard that it cuts the divers' hands as with a knife.

NOTES

PROF. HELMHOLTZ has been appointed Faraday Lecturer for 1881; the lecture will be given early in April.

WE greatly regret to announce the death of Sir Benjamin C. Brodie, Bart., F.R.S., the eminent chemist and late Professor of Chemistry in the University of Oxford. He died on Wednesday, last week, at Torquay, in the sixty-fourth year of his age. We hope to be able to give a detailed notice of Sir Benjamin's life and work in a future number.

THE death, on Sunday, is announced of Mr. Mark Firth, at Sheffield, in the sixty-second year of his age. Mr. Firth was eminent for his discriminating liberality, and will be specially known to our readers as the founder of the well-known Firth College, Sheffield, opened by Prince Leopold last year.

PROF. J. CHARLES D'ALMEIDA, whose sudden death at Paris we mentioned a fortnight since, was one of the prominent leaders in the scientific circles of the French capital. Formerly a Professor of Physics in the Lyceum of Henry IV., he had occupied for some years past the important and responsible position of Inspector-General of Public Instruction. A strong Liberal in matters of education, he exercised a marked influence in the late reorganisation of the French educational system. It was almost entirely owing to his efforts that the Société Française de Physique owes its creation, and since its origin he has occupied the post of secretary. As an investigator D'Almeida is best known by his valuable researches on the phenomena of electrolysis, on galvanic batteries, on capillary phenomena, &c. One of the most remarkable services he has rendered was the invention of the photographic despatches by means of which, during the siege of Paris, the inhabitants of the city were enabled to avail themselves so extensively of the otherwise limited services of the "pigeon post."

A SHORT time ago we alluded to the severe loss to chemical and technical literature by the death of Prof. von Wagner, who for twenty-five years past has conducted so ably his admirable *Jahresbericht für die chemische Technologie*. The difficult question of finding a successor in the editorship of this important annual has been happily solved by the choice of Dr. Ferd. Fisher, Professor of Technology at the Polytechnic of Hanover. For a long time past Prof. Fisher has rendered valuable literary services in editing *Dingler's Polytechnisches Journal*, the most important technical publication on the Continent. As an investigator he is also well known by his elaborate researches on water in its technical and physiological relations, on pyrometry, and on numerous other chemical and technical questions. Under the new auspices the *Jahresbericht* has every reason to look forward to a continuance of its successful career.

M. CHARCOT reopened last week his course of botany at Salpetrière, where he exhibited last year the curious phenomena of female patients suffering from neuro-mental affections. New instances will be produced of cures analogous to the troubles regarded in mediæval times as produced by demoniacal agency or cured by witchcraft.

IN a lecture on earthquakes delivered in Vienna on the 22nd inst., Prof. v. Hochstetter designated the Agram earthquake (affecting elliptically a region of 60 to 80 German miles diameter, and having its larger axis directed south-south-west to north-north-east) as a tectonic or dislocation-earthquake—a name which originated with the Austrian geologist Prof. Hörnes. Prof. Süss expressed a similar opinion in a lecture on November 24, "On Earthquakes in the Alps."

ON Sunday evening, about six o'clock, slight shocks of earthquake were felt at two different places in Scotland—one being Callander, in Perthshire, and the other Inverary, in Argyllshire. The two districts affected are about forty miles apart, in a line due east and west. The shock was also felt at Rothesay and Stornoway. In the north of Ireland during Sunday evening and also the earlier hours of yesterday morning several decided shocks of earthquake were felt, especially in Londonderry and its vicinity. The disturbance was more particularly felt at Innishowen, and it seemed to travel across the bed of the River Foyle to the County Derry side, where the effects were felt strongly.

AT DORTMUND there was a slight shock of earthquake on November 25, and a smart one on the 27th.

MR. MUNDELLA has been speaking on education again, repeating essentially the old story, that our country must lose in the race unless, as in other countries, education in science is made an imperative part of elementary education. We have many natural and traditional advantages over other countries, but all these must in the long run succumb to scientific training.

A MAGNIFICENT lacustrine find has been made in the marshes of Corcelletes, near Consise, in Canton Vaud. It consists of a

fine canoe in a perfect state of preservation, 11 metres 16 centimetres long, and slightly more than a metre broad. It was dug out and drawn from the marsh by sixty men and eight oxen, under the superintendence of the director of the Museum of Lausanne, and has been placed in the court of the Lausanne Academy, where it is destined to remain.

We have before us the reports for last year of the two clubs which have for their object the furtherance of the special study of British plants and their distribution over the surface of the islands. The Botanical Exchange Club has been in existence about twenty-five years, and was a continuation of the London Botanical Society. The Secretary sends out each spring a list of the plants that are wanted, and the members, who are about thirty in number, at Christmas send in their parcels and lists of desiderata. All doubtful specimens are submitted to competent referees, and after the distribution is made a report is published on critical forms and extensions of distribution. The most interesting find noticed this year is the discovery of *Herniaria hirsuta*, a plant spread widely through the southern half of Europe, by Mr. Fred. Townsend at Christchurch, in Hampshire. Dr. Boswell identifies the prickly comfrey, which has been so much talked about lately as a forage plant, with the *Symphytum uplandicum* of Nyman. Probably it is really a hybrid between *S. officinale* and *S. asperrimum*, as was suggested lately when it was figured by Sir Joseph Hooker in the *Botanical Magazine*. Some curious observations have been made lately tending to show that our wild docks hybridise naturally not unfrequently, like verbascums, geums, primulas, thistles, and epilobia. There is a curious form of *Ophioglossum* (*O. vulgatum*, var. *ambiguum* of Cosson and Germain), which till now has been known in Britain only in the Orkney and Scilly Islands. This year Mr. Chas. Bailey has found it on the Welsh coast between Harlech and Barmouth. The Botanical Record Club has for its object the filling up of the blanks left by Mr. Watson when he traced out in detail the home-distribution of British plants in his "Cybele Britannica." In the report for this year detailed lists are given for Cardiganshire and Peebles-shire, and the only counties for which lists of flowering plants now remain to be drawn up are Flintshire, Wigtonshire, and West Ross. Fourteen pages of the present report are occupied by fresh records for counties already worked up, and the Club is now turning its attention to the distribution of the lower cryptogamia, especially mosses. The registration of flowering plants is in the hands of Dr. F. A. Lees of Wetherby, and of mosses in that of Mr. H. Boswell of Oxford; and the Secretary of both the Clubs is Mr. Chas. Bailey, F.L.S., of Manchester.

Mr. Brian Houghton Hodgson, F.R.S., has just presented to the Anthropological Institute a valuable portfolio of drawings illustrative of the Eastern Himalayas and Tibet. The drawings have been made by the same Nepalese draughtsman as delineated the zoological drawings which have been presented to the Zoological Society, and this ethnological series comprises and contains in all 521 subjects, including duplicates. A series of crania have been drawn by aid of the camera, Mr. Hodgson remarking "native patience, hand and eye being peculiarly fitted to work that instrument."

Etienne Mulsant, one of the most prominent of French entomologists, and librarian to the city of Lyons, died on November 4 at the great age of eighty-four. His earliest publication was the "Lettres à Julie sur l'Entomologie (en prose et en verse)," published in 1830, but for the most part consisting of real love-letters to the lady he afterwards married, and written before he was out of his teens. His writings are most voluminous; but he was best known as the author of a work extending over nearly forty years, on the *Coleoptera* of France, and published (chiefly) in the *Annales* of the Linnean Society of Lyons. He was also the author of a magnificently illustrated work on Humming Birds, in connection with which he visited London about five years ago.

We learn that Messrs. Williams and Norgate are about to issue an important work on the Fishes of Great Britain and Ireland by Dr. Francis Day, late Inspector-General of the Fisheries of India. This work deals with their economic uses, modes of capture, diseases, breeding, life-history, &c., with an introduction on the structure of fishes generally, their functions and geographical distribution. The first part appears this month, and is illustrated by twenty-seven plates. The whole will form a work of 700 pages royal octavo, with over 200 plates.

The exploration of the remains of prehistoric man is being actively carried out in Russia. We have already briefly noticed a contribution to this subject by M. Mereshkovsky, published in the *Izvestia* of the Russian Geographical Society (vol. xvi. No. 2), being a report upon the exploration of caverns and rock-shelters in the Crimea, in the neighbourhood of the Tchatyrdagh Mountain. A great cavern, 145 feet wide and 58 feet deep, was explored close by the Suren town, and M. Mereshkovsky found there the remains of a prehistoric workshop for the manufacture of stone implements, the whole belonging to two distinct periods. The paper by M. Mereshkovsky, published in the *Izvestia*, is accompanied with four tables of drawings of stone implements.

We notice the following interesting communications which were made at the last meeting of the St. Petersburg Geological Society:—On the motion of downs near Sestroretsk, by M. Sokoloff. The velocity of these downs is about one foot per month.—On the excavations made by water in rivers and springs of Northern Esthonia, especially by the waterfalls near Reval, Yagowal, and Fal; and on the Devonian clays discovered by Prof. Inostrantseff in the cuttings of the new Ladoga canal. The upper parts of the beds of these clays are bent by the action of the ice of the ice period, as has been observed at many places in Great Britain; the peats which cover the glacial formations are full of remains of prehistoric man.

We can state that the Observatory of Algiers will not remain longer without an astronomical observer. M. Tripier, who has been appointed director, as has been announced in the French papers, will leave in time for installation at the meeting of the French Association for the Progress of Science in April, 1881.

The purchaser of the French Siemens patent is preparing to send a tender for establishing an electric railway from the Exhibition to the central parts of Paris.

ABNORMAL VARIATIONS OF BAROMETRIC PRESSURE IN THE TROPICS, AND THEIR RELATION TO SUN-SPOTS, RAINFALL, AND FAMINES[1]

II.

Comparison of the Abnormal Barometric Variations with the Sun-Spots

A GLANCE at the barometric and sun-spot curves is sufficient to show that the irregular and frequent fluctuations of pressure are relatively much larger than those of the sun-spots. In order therefore to compare the general course of the barometric curves with that of the sun-spot curve the numbers of Table I. have been further smoothed by taking the means of every nine consecutive quarterly values of the nine-monthly means. The results of this operation are given in the following table, and graphically represented by the dotted curves which are drawn through the continuous ones. All these dotted barometer curves closely resemble each other, except that portion of the Mauritius curve after the year 1865 which shows a tendency to assume an opposite character. They are also very similar to the sun-spot curve, but all of them lag very persistently behind the latter, as will be seen by comparing the points marked with the same capital letters:—

[1] Continued from p. 91.

TABLE II.

Means of every Nine Consecutive Quarterly Values of the Nine-Monthly Means of Solar Spotted Area and Abnormal Barometric Pressure

Year.		Solar spotted area in millionths of visible hemisphere.	Abnormal barometric pressure in thousandths of an inch.					
			St. Helena.	Bombay.	Madras.	Calcutta.	Batavia.	Zi-ka-wie.
1841	1							
	2	396						
	3	359						
	4	316						
1842	1	284	− 5					
	2	244	− 4					
	3	216	− 3		− 6			
	4	188	− 1		− 5			
1843	1	171	0		− 4			
	2	164	0		− 3			
	3	161	− 1		0			
	4	164	− 1		+ 2			
1844	1	182	0		+ 4			
	2	208	+ 2		+ 5			
	3	235	+ 4		+ 6			
	4	268	+ 5		+ 8			
1845	1	319	+ 6		+11			
	2	378	+ 7		+13			
	3	426	+ 8		+14			
	4	480	+ 8		+14			
1846	1	530	+ 8		+12			
	2	582			+10			
	3	658			+ 9			
	4	762			+ 6			
1847	1	856			+ 2			
	2	911			− 3			
	3	946			− 6			
	4	1005			− 9			
1848	1	1053			−11			
	2	1080			−13			
	3	1071		− 7	−15			
	4	1022		− 8	−17			
1849	1	947		− 7	−17			
	2	866		− 6	−16			
	3	804		− 4	−16			
	4	762		− 4	−15			
1850	1	709		− 4	−14			
	2	662		− 5	−11			
	3	626		− 6	−10			
	4	611		− 7	− 8			
1851	1	610		− 6	− 6			
	2	604		− 6	− 5			
	3	602		− 6	− 2			
	4	598		− 7	− 1			
1852	1	585		− 7	+ 1			
	2	560		− 6	+ 2			
	3	532		− 5	+ 4			
	4	498		− 1	+ 6			
			Mauritius.					
1853	1	452		+ 1	+ 8			
	2	392		+ 3	+ 9			
	3	346		+ 3	+ 8			
	4	312		+ 2	+ 7			
1854	1	281		+ 2	+ 8			
	2	239		+ 4	+ 7			
	3	191	−12	+ 5	+ 8	− 1		
	4	147	− 8	+ 6		+ 1		
1855	1	113	− 6	+ 6		+ 3		
	2	93	− 7	+ 5		+ 3		
	3	82	− 8	+ 3		+ 3		
	4	70	−10	+ 3		+ 2		
1856	1	57	−11	+ 3		− 1		
	2	52	−11	+ 1		− 5		
	3	67	−12	0		− 6		
	4	106	−14	− 1		− 6		

Year.		Solar spotted area in millionths of visible hemisphere.	Abnormal barometric pressure in thousandths of an inch.					
			Mauritius.	Bombay.	Madras.	Calcutta.	Batavia.	Zi-ka-wie.
1857	1	161	−15	− 2		− 5		
	2	224	−16	− 2		− 7		
	3	309	−15	− 2		− 7		
	4	422	−11	+ 1		− 5		
1858	1	543	− 4	+ 3	+12	0		
	2	669	+ 3	+ 5	+15	+ 4		
	3	814	+ 6	+ 7	+16	+ 9		
	4	957	+ 7	+ 7	+16	+10		
1859	1	1065	+ 6	+ 5	+14	+ 8		
	2	1145	+ 3	+ 4	+12	+ 6		
	3	1221	+ 2	+ 4	+ 9	+ 4		
	4	1289	+ 1	+ 2	+ 7	+ 2		
1860	1	1325	− 2	− 1	+ 2	− 1		
	2	1356	− 7	− 4	− 5	− 7		
	3	1369	−12	− 6	− 6	−12		
	4	1347	−16	− 8		−15		
1861	1	1296	−17	− 8		−17		
	2	1289	−17	− 9		−16		
	3	1292	−17	−11		−15		
	4	1292	−20	−15		−16		
1862	1	1237	−21	−18		−17		
	2	1161	−22	−18		−17		
	3	1060	−21	−19		−18		
	4	983	−21	−18		−19		
1863	1	930	−19	−16		−19		
	2	922	−15	−15		−18		
	3	867	−11	− 9		−17		
	4	821	− 5	− 4		−14		
1864	1	747	+ 1	+ 1		− 8		
	2	702	+ 6	+ 5		− 2		
	3	668	+11	+ 8		+ 3		
	4	672	+14	+11		+ 8		
1865	1	657	+15	+13		+11		
	2	618	+15	+12		+13		
	3	528	+15	+11		+13		
	4	452	+16	+ 9		+14		
1866	1	367	+17	+ 8		+14		
	2	308	+17	+ 8		+13		
	3	274	+16	+ 9		+12		
	4	262	+13	+11		+13		
1867	1	248	+11	+14		+15		
	2		+ 9	+16		+19		
	3		+ 8	+18		+21	+12	
	4		+ 8	+21		+23	+15	
1868	1		+ 7	+22		+23	+17	
	2		+ 7	+22		+22	+18	
	3		+ 8	+22		+20	+18	
	4		+ 9	+19		+18	+17	
1869	1		+11	+15		+13	+15	
	2		+12	+10		+ 8	+10	
	3		+14	+ 7		+ 4	+ 6	
	4		+16	+ 2		+ 1	+ 2	
1870	1		+18	− 3		− 1	− 3	
	2		+20	− 6		− 3	− 6	
	3		+20	− 8		− 5	− 8	
	4		+22	− 8		− 6	−10	
1871	1		+23	− 7		− 6	−10	
	2		+22	− 6		− 3	− 9	
	3		+21	− 5		0	− 9	
	4		+19	− 7		0	−10	
1872	1		+16	− 7	−11	0	−11	
	2		+13	− 7	−11	− 2	−12	
	3		+11	− 6	−11	− 1	−12	
	4		+10	− 5	−10	− 1	−11	
1873	1		+ 6	− 4	−10	0	− 9	
	2		+ 4	− 2	− 9	+ 1	− 8	
	3		+ 2	− 2	−10	+ 1	− 7	
	4			− 2	−10	+ 2	− 7	
1874	1			0	−10	+ 2	− 5	
	2			+ 1	− 9	+ 2	− 3	
	3			+ 2	− 8	+ 3	− 1	− 5
	4			+ 2	− 8	+ 2	− 3	− 7

TABLE II. (*Continued*)—

Year.		Solar spotted area in millionths of visible hemisphere.	Abnormal barometric pressure in thousandths of an inch.					
			Mauritius.	Bombay.	Madras.	Calcutta.	Batavia.	Zi-ka-wei.
1875	1			0	−10	0	− 4	− 8
	2			− 1	−12	− 2	− 6	− 9
	3			− 1	−13	− 3	− 7	− 9
	4			+ 2	−10	− 1	− 4	− 8
1876	1			+ 6	− 5	+ 2	+ 1	− 7
	2			+13	+ 3	+ 7	+ 7	− 6
	3			+16	+10	+13	+13	− 3
	4			+20		+17	+18	+ 2
1877	1			+23		+24	+23	+ 8
	2			+25		+31	+26	+13
	3			+23		+37	+26	+16
	4			+18		+38		+16
1878	1			+11		+32		+14
	2			+ 7		+26		+13
	3			+ 1		+21		+12
	4			− 4		+16		+ 9
1879	1			− 9		+11		
	2							
	3							
	4							

The epochs of maximum and minimum barometric pressure and of minimum and maximum sun-spot area, as determined from the dotted curves by the graphic method, are given in the following table :—

Epochs of Maximum and Minimum Barometric Pressure and Solar Spotted Area

Solar spotted area.	Barometric pressure.						
	St. Helena.	Mauritius.	Bombay.	Madras.	Calcutta.	Batavia.	Zi-ka-wei.
Min. in July 1843.	Max. in Nov. 1845.	—	—	Max. in Aug. 1845.	—	—	—
Max. in May 1848.	—	—	Min. in Sept. 1848.	Min. in Dec. 1848.	—	—	—
Min. in April 1856.	—	Max. in Oct. 1858.	Max. in Aug. 1858.	Max. in Aug. 1858.	Max. in Sept. 1858.	—	—
Max. in June 1860.	—	Min. in April 1862.	Min. in Aug. 1862.	—	Min. in Jan. 1863.	—	—
Min. in February 1867.	—	?	Max. in May 1868.	—	Max. in Nov. 1867.	Max. in May 1868.	—
—	—	?	Min. in Sept. 1870.	—	Min. in Nov. 1870.	Min. in Dec. 1870.	—
—	—	—	Max. in April 1877.	—	Max. in Sept. 1877.	Max. in May 1877.	Max. in Sept. 1877.

The mean epochs are given below and compared with those of the solar spotted area.

Mean Epochs of Barometric Pressure compared with the Corresponding Epochs of Solar Spotted Area[1]

Solar spotted area. *a.*			Barometric pressure. *b.*			Difference. *b*–*a.*		
	Year.	Month.		Year.	Month.		Year.	Month.
Min.	1843	7·5	Max.	1845	10·0		+ 2	2·5
Max.	1848	5·5	Min.	1848	11·0		+ 0	5·5
Min.	1856	4·5	Max.	1858	9·2		+ 2	4·7
Max.	1860	6·5	Min.	1862	8·8		+ 2	2·3
Min.	1867	2·5	Max.	1868	3·5		+ 1	1·0
				Mean			+ 1	8·0

From this comparison it appears that the epochs of maximum and minimum barometric pressure lagged behind the corresponding epochs of minimum and maximum solar spotted area at an interval varying from above six months to nearly two and a half years, or at an average interval of about one year and eight months.

Making use of this result and comparing points of the pressure curves with points of the solar curve several months earlier, it will be seen that even the minor peculiarities of the pressure curves from 1863 to 1868 do bear some resemblance to the subordinate features of the sun-spot curve from 1862 to 1867. What appear to be corresponding points have been marked with corresponding letters. It is remarkable that this part of the sun-spot curve is the very portion which has been most accurately determined by means of the Kew photoheliograph.

Comparison of the Abnormal Barometric Variations with Past Famines.—According to the Report of the Famine Commission the famine of 1876-78 in Southern India was *the most widespread and severe* of any which have occurred in India during the present century, and on reference to the curves it will be seen that the abnormal barometric pressure during those years was the *highest on record*. In the year 1878 a famine occurred in the North-West Provinces also, in consequence of a deficiency of rain in the previous year.

The famine next in severity to that of 1876–78, and of even greater extent, was the one of 1868–69, which affected Rajputana and the North-West Provinces. The curves show that this also was accompanied or immediately preceded by a *wave of high barometric pressure*, which reached its maximum near the middle of the year 1868.

The next on the list of severe famines is that which occurred in Orissa in the years 1865-66, and it will be seen that this also was attended by a *wave of high pressure* which slowly passed over India in the years 1864-65.

The less extensive Behar famine of 1873-74 was also accompanied by a small wave of high pressure, which, judging from the curves for Mauritius, Bombay, Madras, and Batavia, reached its maximum height towards the end of 1873.

The famine of 1860-61 in the North-West Provinces was also preceded by a wave of high pressure in the year 1859, although the failure of the rains which induced this famine did not occur till the following year.

The above-mentioned famines include *all* the severe ones that have occurred in India since 1841, the year from which barometric data exist; and the waves of high barometric pressure which have been mentioned in connection with them include *all* that have been observed except two, viz. the one in 1855 and the one in 1845, both of which, though not immediately followed by actual famine, were nevertheless accompanied by deficient rainfall both at Madras and Bombay, the fall at the former station being 67 and 78 per cent. of the average in 1855 and 1845 respectively, and at the latter station 58 and 77 per cent. in the same years. Between the years 1832 and 1840, during which the solar spotted area was accurately observed, but for which period I have no barometric data, two other severe famines occurred, viz. the Gantur famine of 1833, and the famine of 1837-38 in Northern India; and it is worthy of note that the first of these occurred soon after the sun-spots had somewhat suddenly fallen to a minimum in 1832, and when, therefore, the barometric pressure would assumably be high, the second soon after the great and sudden diminution of spots which took place early in the year 1837. This last occurrence was very similar to the great decrease of spots observed in 1863, on which occasion

[1] The numbers 1, 2, 3, &c., under the heading "Month," refer to the months January, February, March, &c., respectively, and the decimals of month are reckoned from the beginning of the respective months.

the decrease was followed by the wave of high pressure which preceded the Orissa famine.

Hence it appears that widespread and severe famines are generally accompanied or immediately preceded by waves of high barometric pressure.

Means whereby future famines may possibly be foreseen.—If the conclusions arrived at from the above comparisons of abnormal barometric variations, sun-spots, and past famines be admitted, it is clear that they at once present the means whereby future famines may possibly be foreseen. The conclusions are briefly:—

1. That variations of the solar spotted area are *succeeded many months afterwards* by corresponding abnormal barometric variations.

2. That abnormal barometric variations in the tropics travel at a very slow rate round the earth from west to east, arriving at westerly stations *several months before* they reach more easterly ones.

3. That famines follow in the wake of waves of high barometric pressure.

Hence it follows that there are two methods by which early intimation of the approach of those meteorological disturbances which are attended by famines may possibly be obtained—

1. By regular observation of the solar spotted area, and early reduction of the observations, so as to obtain early information of current changes going on in the sun.

2. By barometric observations at stations differing widely in longitude, and the early communication of the results to stations situated to the westward.

With regard to the first of these methods it is sufficient to state that the whole subject of solar observations is now being investigated by a committee of scientific gentlemen in London, and we may therefore hope that the all-important information which solar observations are capable of affording will ere long be at our disposal; but with regard to the second method, viz., that of barometric observations at stations differing widely in longitude, it is to be regretted that no observatories of long standing situated in suitable localities to the *westward* of Bombay at present exist, except possibly at the very distant station of Havanna in Cuba. The observatory at St. Helena appears to have been closed in the year 1847, after working continuously for about seven years.

The most suitable localities for barometric observations for the purpose in view are insular stations far removed from the disturbing influences of the large continents and near the equator, such as the Seychelles, St. Helena, and Ascension, but these appear to be at present unoccupied by permanent observatories, while the wide expanse of the Pacific, which is probably the most suitable portion of the earth's surface for investigations of this kind, appears to be entirely unrepresented by any fixed observatory on any of its numerous islands, such as the Galapagos, Sandwich, and Fiji Islands. An observatory has however lately been established at Zanzibar on the East Coast of Africa, from which very valuable observations may be expected if it should continue at work for any great length of time; and another has, I believe, been started at Aden: but as these stations are both situated on the borders of extensive continents, they are not so suitably located as the stations previously mentioned.

It would therefore be necessary, in order to utilise to the fullest extent the second method of foreseeing the approach of a meteorological disturbance of the kind which would probably be attended by famine, that special arrangements should be made for the registration of the needful observations at some, if not all, of the stations that have been referred to; and that the information thus afforded should be rapidly communicated from the more westerly to the more easterly stations.

F. CHAMBERS,
Meteorological Reporter for
Western India

Bombay, September 4

POSTSCRIPT.—In order to determine numerically the intervals of time at which the barometric variations of one station have lagged behind those of another, and behind corresponding minor variations of the sun spots, the times at which the continuous curves cross the dotted ones have been marked off by the graphic method for corresponding crossing points of the different curves, giving the first set of times and intervals in each of the following tables. The same thing has been done with regard to the times at which the continuous curves cross the respective zero lines, giving the second set of times and intervals in each of the tables. As the average pressures for Batavia and Bombay have not been calculated from the observations of the same years, and as the zero line of the Batavia curve is on this account relatively displaced by ·004 of an inch in the upward direction, a new zero line has been drawn so as to make the times at which the continuous curve crosses the zero line comparable with those for Bombay. The approximate longitudes of the stations and their differences are also given in the tables.

Station ...	St. Helena.		Madras.		Madras minus St. Helena.
Longitude.	5° 44′ W.		80° 14′ E.		+ 85° 58′.
	Year.	Month.	Year.	Month.	Month.
First Set.	1842	4·1	1842	9·7	+ 5·6
	1843	11·6	1843	12·8	+ 1·2
	1846	3·2	1846	7·1	+ 3·9
Second Set.	1842	6·8	1842	11·5	+ 4·7
	1843	11·4	1844	1·9	+ 2·5
	1846	6·7	1846	9·1	+ 2·4
				Mean	+ 3·38

Station ...	Mauritius.		Calcutta.		Calcutta minus Mauritius.
Longitude.	57° 31′ E.		88° 25′ E.		+ 30° 54′.
	Year.	Month.	Year.	Month.	Month.
First Set.	1856	3·6	1856	6·5	+ 2·9
	1857	5·2	1857	7·3	+ 2·1
	1858	10·5	1858	10·1	− 0·4
	1859	9·1	1860	1·0	+ 3·9
	1861	4·7	1861	9·0	+ 4·3
	1862	4·1	1862	9·5	+ 5·4
	1863	8·0	1864	6·0	+10·0
Second Set.	1856	1·1	1856	4·7	+ 3·6
	1858	9·0	1858	6·8	− 2·2
	1859	9·8	1859	11·0	+ 1·2
	1863	10·5	1864	5·9	+ 7·4
				Mean	+ 3·47

Station ...	Bombay.		Calcutta.		Calcutta minus Bombay.
Longitude.	72° 48′ E.		88° 25′ E.		+ 15° 37′.
	Year.	Month.	Year.	Month.	Month.
First Set.	1856	2·5	1856	6·5	+ 4·0
	1857	7·2	1857	7·3	+ 0·1
	1858	5·0	1858	2·8	− 2·2
	1858	8·9	1858	10·1	+ 1·2
	1859	7·5	1859	10·7	+ 3·2
	1861	7·5	1861	9·0	+ 1·5
	1862	6·7	1862	9·5	+ 2·8
	1863	11·1	1864	6·0	+ 6·9
	1865	1·8	1865	9·3	+ 7·5
	1866	1·1	1866	10·2	+ 9·1
	1867	1·5	1867	7·0	+ 5·5
	1867	12·8	1867	10·8	− 2·0
	1869	6·9	1869	8·7	+ 1·8
	1870	6·9	1870	7·1	+ 0·2
	1876	10·1	1876	9·3	− 0·8
	1878	5·4	1878	8·8	+ 3·4

Second Set.	1856	3·1	1856	4·7	+ 1·6
	1857	7·8	1857	9·1	+ 1·3
	1859	9·2	1859	11·0	+ 1·8
	1863	11·5	1864	5·9	+ 6·4
	1869	8·2	1869	9·2	+ 1·0
	1876	4·8	1876	7·8	+ 3·0
	1878	5·9	1878	10·5	+ 4·6
				Mean	+ 2·69

Station ...	Bombay.		Batavia.		Batavia minus Bombay.
Longitude.	72° 48′ E.		106° 50′ E.		+ 34° 2′.
	Year.	Month.	Year.	Month.	Month.
First Set.	1867	12·8	1868	2·1	+ 1·3
	1869	6·9	1869	8·5	+ 1·6
	1872	4·5	1872	5·6	+ 1·1
	1873	5·8	1873	6·8	+ 1·0
	1874	5·4	1874	6·7	+ 1·3
	1875	3·7	1875	4·9	+ 1·2
	1875	9·7	1875	10·0	+ 0·3
	1876	10·2	1876	9·8	− 0·4
Second Set.	1869	8·1	1869	10·0	+ 1·9
	1873	6·2	1873	7·5	+ 1·3
	1874	5·7	1874	7·5	+ 1·8
	1875	4·0	1875	6·0	+ 2·0
	1875	11·2	1875	9·7	− 1·5
	1876	4·9	1876	6·1	+ 1·2
	1878	5·9	1878	7·9	+ 2·0
				Mean	+ 1·07

	Solar spotted area.		Bombay barometer.		
	Year.	Month.	Year.	Month.	Month.
First Set.	1862	3·4	1862	6·7	+ 3·3
	1863	1·3	1863	11·1	+ 9·8
	1863	11·7	1865	1·8	+14·1
	1864	12·7	1866	1·1	+12·4
	1865	9·4	1867	1·5	+16·1
	1866	6·0	1867	12·8	+18·8
				Mean	+12·4

	Solar spotted area.		Madras barometer.		
	Year.	Month.	Year.	Month.	Month.
First Set.	1849	6·7	1849	12·8	+ 6·1
	1850	11·2	1851	5·4	+ 6·2
				Mean	+ 6·1

It will be seen that in the great majority of cases the barometric waves reach the westerly station several months before they arrive at the more easterly one, but that the rate of progression of these waves across the Indian Peninsula appears to be much slower than across the open ocean to the southward.

F. C.

THE ROYAL SOCIETY—ADDRESS OF THE PRESIDENT[1]

DR. SPOTTISWOODE began by referring to the losses which the Society has sustained by death during the past year:—Prof. Miller, Dr. Sharpey, Mr. Lassell, Prof. Ansted, Lord Belper, Mr. E. W. Cooke, and Sir Benjamin Collins Brodie.

The Society's finances generally are, as the balance-sheet will show, in a healthy condition, and appear to justify the hope that they will suffice for the large claims upon them for printing our publications. The address then proceeds:—

Although we are more concerned, Dr. Spottiswoode said, with the quality than with the quantity of communications made to the Society, it may not be without interest to observe that the number of papers received this year has been in excess of that in any previous year, at all events since 1872, inclusive. The following is a table of the numbers during the last nine years:—

1872	... ...	99 papers	received.
1873	... ...	92 ,,	,,
1874	... ...	98 ,,	,,
1875	... ...	88 ,,	,,
1876	... ...	113 ,,	,,
1877	... ...	97 ,,	,,
1878	... ...	110 ,,	,,
1879	... ...	118 ,,	,,
1880	... ...	123 ,,	,,

and we may conclude that these have contained good matter from the fact that of the *Philosophical Transactions* for the current year Parts i. and ii., already published, contain no less than 900 pages and thirty-three plates.

Dr. Spottiswoode then referred to the satisfactory results of the change of time of meeting of the Society, and went on to speak of the death of Mr. Henry White, who for many years was chief assistant in the compilation of the great Catalogue of Scientific Papers. At an earlier stage of the work, Dr. Spottiswoode went on to say, his loss would have been still more serious; but in a long course of training he succeeded so well in imparting his own careful and methodical mode of work to those under him, that the Council felt justified in making trial of his son to take his place. With the result of this trial, as shown in continuing the preparation of a new edition of the catalogue of the Society's Library, the Council has reason to be satisfied. Of this new edition, the first portion, 220 pages, containing our large collection of *Transactions* and *Proceedings* of Academies and Societies, and other scientific periodicals is in type, and will shortly be printed off. The verification of titles of our scientific books generally is so far advanced as to warrant the expectation that a large instalment of this portion of the catalogue will soon be in the printer's hands; after which we anticipate no further delay.

In regard to the Library, a question has arisen as to how far purely literary works, which occupy much space, should be retained. Among them there are doubtless some which add neither to the utility nor to the scientific importance of our Library, but there are also some early printed books, bibliographical treasures, which are worthy of a place in any collection. It is proposed to have these carefully put in order, and to place them in a case by themselves. Among these, there may be mentioned:—

Caxton's Chaucer, 1480.
Pynson's Chaucer, 1492.
Speght's Folio Chaucer, 1598.
Ciceronis Officia et paradoxa, Fust, 1466, vellum.
The generall historie of Virginia, Lond. 1632.
Bonifacius. Sextus decretalium liber. Ven. 1566-7
Plautus, 1482. Seneca, 1490.
Ovid, 1485. Statius, 1490.
Plutarch, 1485. Herodotus, 1494.
Homer, 1488.

For bringing into prominence these as well as other features of our miscellaneous, *i.e.* non-scientific, books, we are greatly indebted to the care and knowledge brought to bear on the subject by Mr. Tomlinson, and by our treasurer.

Although it is doubtless undesirable to propose, without sufficient cause, alterations in our statutes, or even in our practice, it is still often worth while from time to time to discuss questions involving such alterations in order that we may be prepared for a

[1] Address of William Spottiswoode, D.C.L., LL.D., the President, delivered at the Anniversary Meeting of the Royal Society on Tuesday, November 30, 1880

deliberate judgment whenever occasion may arise. Among such subjects there is one upon which I have often heard opinion expressed, and upon which opinion has always weighed in the same direction: I allude to the period of office of those elected to serve on the Council of the Society. By the terms of our charter ten of the ordinary members retire every year; and as it is our custom to remove six according to seniority and four in respect of least attendance, it rarely happens, although the contrary is possible, that any Fellow, except those holding the posts of President, Treasurer, or Secretary, should remain in office more than two years. Experience, however, appears to show, that for a member serving on the Council for the first time, there is so much to learn, so many heads of business which do not in general come before the Fellows at large, that his first year is occupied quite as much in ascertaining his duties as in actively performing them. This objection is in some degree met by selecting for the ten incoming members five who have served before, and five who have not so served; but, nevertheless, there is usually an interval of several years between two periods of office, and as a matter of fact we often lose a member of Council at the moment when his advice is becoming most valuable to our body.

I am aware of the great convenience attaching to our present impersonal mode of selecting the members to retire in each year, and am not at present prepared to suggest any specific alteration. But the great confidence which the Society has, especially of late years, placed in its more permanent officers, and the power which naturally accrues to them from the comparatively short tenure of office by the other Members of Council, appear to me to be points of which the Society should not lose sight. On the part of the officers I think it right to state that we are very sensible both of the honour which is thus done to us and of the responsibility which is thereby entailed, and that we hope never to discredit the one nor to abuse the other. And having said so much, we are quite willing to leave the matter in the hands of the Society to be taken up whenever they see reason so to do.

It will be in the recollection of the Fellows that the position of the Royal Society in respect of the Government Fund of 4000*l.* per annum is different from that in relation to the Government Grant of 1000*l.* per annum. In the latter case the sum is placed unreservedly in the hands of the Society for promoting scientific investigation, subject only to an annual report to the Treasury of the disposal of it; and, in administering it, the Society has in no case applied it to the personal remuneration of the applicant. In the former case the Society has been requested to advise the Science and Art Department as to the distribution of the grant, not only for the direct expenses of investigations, but also for personal remuneration for the time expended on them, whenever the circumstances and wishes of the applicant appeared to render this desirable. The responsibility of this advice lies with a Committee similar to that of the Government Grant, but with the addition of the presidents of certain learned bodies and societies, nominated for that purpose by the Government.

The recommendations made by the Committee each year are annually published in the *Proceedings*, so that the public will have had full information as to the distribution of the grant; while the Fellows have the opportunity of seeing the nature of applications made, and the extent to which it has been found practicable to meet them, as recorded in the minutes of the Council of the Society.

One of the points which is perhaps beset with the greatest difficulty is that of the so-called "personal" grants. On the one hand it has been argued that it is desirable to enable the man of small means to devote to research a part of his time which he could not otherwise afford to give; but, on the other, the question has been raised whether it be wise, even in the interests of science, to encourage any one not yet of independent income to interrupt the main business of his life. It is too often assumed that a profession or a business may be worked at half-speed, or may be laid down and taken up again, whenever we like. But this is not so, and a profession temporarily or even partially laid aside, may prove irrecoverable; and the temptation to diverge from the dull and laborious path of business may prove to have been a snare. Without proposing to exclude from possible aid in some shape or other those cases where personal assistance may be safely offered, it has been suggested that many such cases may be practically met by grants for the employment of an assistant, instead of grants to the applicant himself.

There is another fundamental difference between the position of the Government Grant of 1000*l.* per annum and the Government Fund of 4000*l.* per annum, which appears to me to be of material importance in the interests of science. The former is an absolute grant from the Treasury made to the Society for scientific purposes. It may be used wholly, or in part, during the year in which it is made, and the balance, if any, may be carried over by the Society to the next or even to succeeding years. The latter is a vote to the Science and Art Department, on the disposal of which the Society is consulted. Like all other similar votes, any unused balance reverts to the Treasury, and is to that extent lost to the purpose for which it was intended. I cannot help thinking that, if any such balances could be reserved and kept in hand, provision might be made for some larger purposes than those to which the fund has hitherto been devoted. And, even if having this end in view, the Committee should not see its way to recommend some of the smaller applications, it may be fairly questioned whether the smaller grants might not find a more appropriate place among those of the Donation Fund of this Society, or of the British Association, or among some of those separate funds which, through the liberality of individuals, are now growing up among the special societies.

I am glad to record the fact that, upon the recommendation of men of science, Her Majesty has been pleased to grant pensions on the Civil List to the widows of two of our late Fellows, viz., to Mrs. John Allan Broun and to Mrs. Clifford.

Last year two volumes containing a collection of the late Prof. Clifford's general lectures and essays were brought out. It is hoped that during the present winter a collection of his mathematical papers will be published. The contributions to science by the late Prof. Rankin have recently been placed in the hands of the public. While very sensible of the obligations under which the scientific world is placed by these posthumous publications, I cannot refrain from alluding to our obligations, even greater if possible, to those who during their lifetime are willing to re-issue their own scientific memoirs, and to give us thereby not only the convenience of ready access, but also the advantage of their own subsequent reflections on the subjects of which they have treated. And at this particular moment I desire to mention more particularly the mathematical and physical papers of our Senior Secretary, Prof. G. G. Stokes; and, while expressing our gratitude for the volume which has already appeared, I would express also our sincere hope that another instalment from the same source may shortly follow.

Among the subjects which at one period of the late session of Parliament engaged the attention of the Government was that of the law relating to vaccination; and a Bill was introduced intended to remove some of the practical difficulties in carrying out the existing law. While fully admitting the difficulties in question, the remedy proposed appeared to trench so closely upon the application at least of a scientific principle, and at the same time to be so important in its practical aspect, that I ventured (although the Council was not sitting) to consult the Presidents of the Colleges of Physicians and of Surgeons, and that of the Medical Council, about addressing the Government on the subject. This resulted in a joint deputation to the President of the Local Government Board, in which I took part as President of the Royal Society. I reported this matter to the Council at their first meeting after the recess, and received their approbation. The Bill in question was withdrawn.

The Royal Commission on Accidents in Coal Mines, the appointment of which I mentioned in my address of last year, has been occupied principally in bringing together a body of valuable evidence on the causes and prevention of accidents in mines generally. The Commission has also visited a number of mines in which serious accidents by explosion have taken place, or in which certain phenomena connected with the occurrence of fire-damp were to be studied. They have also instituted a series of experiments on the behaviour of various safety lamps in mixtures of natural fire-damp and air. These experiments they are about to renew during the winter. They also contemplate carrying out experiments in blasting rock and coal by methods which will check the production of flame, and which are thereby calculated to obviate the danger of igniting fire-damp.

The report of the voyage of H.M.S. *Challenger*, to which the scientific world has been looking forward with so much interest, is now so far advanced that one volume of the "Zoological Memoirs" will appear immediately. In addition to this a second volume may be expected within a year. The first volume of the whole work, "containing a short narrative of the voyage, with all necessary hydrographical details, an account of the appliances and methods of observation, a running

outline of the results of the different observations; and a chapter epitomising the general results of the voyage," together with the second volume containing the meteorological, magnetic, and hydrographic observations, will probably be published within the same period. "The general report on the zoology of the expedition will consist of about fifty distinct memoirs, which will occupy from ten to twelve volumes." It has been arranged "to print the Zoological Reports as they are prepared, and to publish them as soon as a sufficient bulk of memoirs is ready to form a volume. Copies of each memoir may also be had separately, in order that working naturalists may have them in their hands at the earliest possible date." Two more volumes on the geology and petrology, and one on the general chemical and physical results, will probably complete the series. Into the details of the zoological results I am not competent to enter; but the greatest interest attaches to the fact that notwithstanding the pressure and absence of light, there is no depth-limit to animal life.

As the Council of the Meteorological Office is nominated by the Council of the Royal Society, and as the Annual Report of the Office is submitted to the Royal Society, I think it right to mention a few points connected with the work of that department during the past year.

1. A method of recording the duration of bright sunshine by the charring of an object placed in the focus of a glass sphere, freely exposed to the rays of the sun, was devised by Mr. J. F. Campbell of Islay in 1856; and instruments, being modified forms of that originally proposed, have been employed for some time at Greenwich, at Kew, and at a few private observatories. Certain difficulties in adjusting the paper about to be charred to the path of the burning spot, which had hitherto prevented the adoption of Mr. Campbell's invention as a part of the ordinary equipment of a meteorological observing station, have been at last successfully overcome by an arrangement designed by Prof. Stokes; and thirty stations in the British Isles have now been supplied with instruments of the pattern proposed by him. We may thus hope to obtain in future a sufficient record of a meterological element, which is of primary importance in its relations to agricul.ure, and to the public health, but which has hitherto been very imperfectly registered.

2. The climatology of the Arctic regions, in addition to its importance as a part of the general physics of the globe, possesses a special interest in connection with geographical exploration. As a contribution to our knowledge of this subject, the Meteorological Office has entrusted to Mr. R. Strachan the task of bringing together, and discussing on an uniform plan, the results of the observations taken at intervals during the last sixty years, in the region extending from the meridian of 45° W. to that of 120° W., and from the parallel of 60° to that of 80°, either at land stations or at the winter quarters of British and American expeditions. A considerable portion of this discussion has been already published; the remainder may be expected in the course of next year.

3. Another publication of the Meteorological Office may be mentioned as serving to mark the advance in meteorological theory, which has been achieved during the last fifteen years. The old "Barometer Manual and Weather Guide" of the Board of Trade has been replaced, so far as it relates to the weather of the British Isles, by a work entitled "Aids to the Study and Forecast of Weather," prepared under the direction of the Meteorological Office by the Rev. W. Clement Ley. Though some of the views put forward in the later work may, perhaps, be regarded as not sufficiently established by observation, yet a comparison of the two works cannot fail to leave upon the reader's mind the impression that in the interval between their respective dates of publication, some real progress has been made in meteorology. Perhaps this is most conspicuous in the enlarged ideas that are now entertained concerning the conditions upon which the changes of weather depend. Local weather was first discovered to be contingent upon travelling areas of disturbance, each of which averaged many hundreds of miles in diameter, while, at the present time, the relation of these areas to one another, as parts of a single terrestrial system, has become a prominent topic of inquiry. If meteorology has thus been, to a certain extent, rescued from the ever-accumulating chaos of numerical tabulations, which threatened to engulf the whole science, the improvement is mainly due to the development in recent times of the synoptic study of weather over large regions of the earth's surface, to which so great an impetus has been given by the extended facilities of telegraphic communication.

4. Balloon ascents, with a view to military purposes, are now systematically carried on under the direction of the War Office; and the endeavour has been made to take advantage of these ascents for observations of the thickness of the aërial current which causes our winds, and of the peculiarities of the currents above it in the upper strata of the atmosphere. The military authorities have offered their co-operation in the most cordial manner; but the attention of an aëronaut is often so much engrossed by the operations necessary for working his balloon, that he has but little leisure for taking systematic records. Nevertheless, observations of considerable interest have already been obtained, relating especially to the velocity and direction of the upper air currents; and there can be no doubt that a continuance of such observations affords the best prospect at present open to us of adding to the very scanty knowledge which we possess of the movements of the atmosphere, even at a moderate height above the earth's surface.

Among the various duties which the President of the Royal Society is called upon to fulfil, there are those of a Trustee of the British Museum; and, as an operation of great importance to science, namely the removal of the natural history collections to the new building at South Kensington, is now going on, the Fellows may be interested to hear what progress has been made in the work.

The plans for the new building were approved as long ago as April, 1868: but the works were not commenced until the early part of 1873. Their progress was retarded by difficulties in the supply of the terra cotta with which the building is faced within and without, and in which the mouldings of arches and other ornamental features are executed.

The building was finally handed over to the Trustees in the month of June of the present year. It contains cases for three only of the departments for which it is intended, namely, Mineralogy, Geology, and Botany; the necessary funds for the Zoological Department not having yet been voted. As the latter collections are equal in bulk to the other three collectively, it follows that only half the new building can at present be actually occupied. The removal of the collections for which cases had been provided, commenced in the last week of July, and was virtually completed by the end of September.

Geology, which was very inadequately displayed in the old building, is now more commodiously accommodated. It now occupies a gallery 280 feet in length by 52 in breadth, forming the ground floor of the east wing of the new museum, together with eight other galleries covering an area of 200 × 170 feet at the back, and admirably adapted for the exhibition of the specimens. One of these galleries will be devoted to the illustration of stratification.

The principal part of the Minerals has been moved and replaced in the cases in which they were arranged in the old building. The collection now occupies the first floor of the east wing of the new museum, and the space devoted to it is 280 × 50 feet in area. It is already arranged for exhibition.

The Botanical collections are placed in the gallery over the minerals, where the space for exhibition and the conveniences for study are much greater than in their old quarters.

The construction of the cases for the Zoological specimens, and the ultimate removal of these collections, must depend upon the amount of the Parliamentary vote for the purpose; but under the most favourable conditions it can hardly be hoped that this department can be open to the public or to students for two years from the present time.

The "Index Museum," designed by Professor Owen, will form a prominent feature in the new museum. The object of it, in his words, is "to show the type characters of the principal groups of organised beings;" and "to convey to the great majority of visitors, who are not naturalists, as much information and general notions of its aim as the hall they will first enter and survey could be made to afford."

One of the principal difficulties attending the transfer of the Natural History Departments to a separate building consists in the provision of books for the use of the keepers and their staff, as well as for students who may visit the museum. Hitherto the separate collections of books, known as departmental libraries, supplemented as occasion might require from the main library of the museum, have sufficed for all purposes. But now, when the departmental libraries have to stand by themselves, it is impracticable to carry on even the current work of arrangement without additional resources. For an adequate supply of the necessary works a very large outlay would be required, sup-

posing that the works were in the market. But many of them are out of print and have become scarce; and a large grant of public money would perhaps raise the market price almost in proportion to its magnitude. This being so, it has been thought best, on the whole, by the Government to make an annual grant to be expended from time to time as favourable opportunities for purchase may offer. If it should prove possible, and on other grounds desirable, to allow the Banks' Library to follow the collections with which it has always been practically connected, the wants of the Natural History Departments would (so far as books up to the date of its bequeathment are concerned) be in a great measure supplied.

Another of the duties which falls officially on your President is to take part in the organisation of technical education as promoted by the City and Guilds of London Institute, which is now incorporated under the Companies Acts, 1862-80, as a registered association, and of which the Presidents of the Royal Society, the Chemical Society, the Institute of Civil Engineers, and the Chairman of the Council of the Society of Arts, are members. In the Memorandum and Articles of Association of the Institute, its objects are fully set forth. They may be summarised under the following heads:—

1. The establishment of a central technical institution for instruction in the application of science and art to productive industry.

2. The establishment of trade and technical schools in London and in the country.

3. The development of technical education by means of examinations held at the Central Institution, or at other places.

4. To assist by means of grants existing institutions in which technical education is being promoted.

5. To accept gifts, bequests, and endowments for the purposes of the Institute.

The Institute is supported by subscriptions from sixteen of the City Companies, of which the largest contributors are the Mercers, Drapers, Fishmongers, Goldsmiths, and Clothworkers.

The Institute has been in active operation not much more than a year, and during the last six months the work of the Institute has developed considerably in each of its several departments. These may be considered under the following heads:—

1. Technical Instruction.
2. Examinations in Technology.
3. Asssistance to other Institutions.

1. Since November last courses of lectures and laboratory instruction have been given in the temporary class-rooms of the Institute, at the Cowper Street Schools, under the direction of Prof. Armstrong, F.R.S., and of Prof. Ayrton. The subjects of instruction have included Inorganic and Organic Chemistry, with special reference to their industrial applications; Fuel, Electro-depositions of Metals, and Photographic Chemistry; General Physics, Steam, Electrical Engineering, Electrical Instrument Making, Electric Lighting, Weighing Appliances, and Motor Machinery.

During the term ending July last the number of tickets issued to students, most of whom belonged to the artisan class, exceeded three hundred. A considerable accession of students is expected as soon as the building in Tabernacle Row, the plans of which are already settled, shall be erected. This building, which is estimated to cost £20,000*l.*, will provide accommodation for schools of Technical Physics, Technical Chemistry and Applied Mechanics. Many of the day students at these classes are pupils of the Cowper Street Schools, and it is expected that, by adapting the course of technical instruction to be given in the College to the wants of these boys, a very complete technical school for the children of artisans will have been established.

The evening lectures and laboratory instruction, which are more advanced and more special, are attended very largely by external students, for whom the present temporary accommodation is already too limited.

At Kensington, schools have been established in which practical instruction is given in various art subjects, such as Painting and Drawing, Modelling, Designing, and Wood Engraving. These schools are attended by both sexes, and are under the immediate direction of Mr. Sparkes. The numbers in attendance last term were as follows:—

Wood Engraving . . .	8 Students,	3 Men,	5 Women.
Modelling	28 ,,	26 ,,	2 ,,
Drawing and Painting from Life	42 ,,	19 ,,	23 ,,
Designing	33 ,,	3 ,,	30 ,,

The Central Institution for instruction in the application of the higher branches of science to industrial pursuits is about to be erected on a plot of ground in Exhibition Road, granted by the Commissioners of 1851. The construction of this building, which, when completed, will cost 50,000*l.*, has been entrusted to Mr. Alfred Waterhouse, who is now engaged in the preparation of plans.

2. In the year 1879, the examinations in Technology, which had been initiated by the Society of Arts, were transferred to this Institute. Various changes where introduced into the regulations. New subjects were added, and in order to stimulate the teaching of Technology throughout the country, the principle of payment to teachers on the results of the examinations was adopted. The encouragement thus afforded to teachers gave a great impetus to the formation of classes throughout the country in technological subjects. Last year the number of candidates for examination was 202, while at the recent examination, held in May, 816 candidates presented themselves, of whom 515 satisfied the Examiners. During the last few months the number of classes throughout the country, in which technical instruction is being given, has considerably increased, and, judging from the returns already received, there is reason to believe that the number of candidates, who will present themselves for examination next May will be much greater than in either of the preceding years. The new programme, which is just issued, contains a syllabus of each subject of examination, and every effort has been made, short of testing the candidates' practical skill, to make the examinations as efficient as possible. To obtain the Institute's full certificate, each candidate is required to give evidence of having obtained some preliminary scientific knowledge.

3. In order to take advantage of efforts that are already being made to advance technical education, the Institute has given sums of money for specific objects to several institutions in which technical instruction is provided. The schools, colleges, and other bodies which have received grants from this Institute, are University College and King's College, London, the School of Art, Wood Carving, and Mining Association of Devon and Cornwall, the Nottingham Trade and Science Schools, the Artisans' Institute, the Birkbeck Institute, the Lancashire and Cheshire Union, and the Horological Institute.

The Artisans' Institute gives practical instruction in several of the humbler crafts in which artisans are engaged, such as carpentry, zinc work, and plumbers' work; and corresponds, therefore, to some slight extent with the apprenticeship schools of the Continent, from which, however, it differs in many important particulars. A similar experiment is being tried at the Horological Institute, where, at the expense of the Guilds, classes have been organised, in which apprentices receive practical instruction in the various branches of the watch-making trade.

It is found that the demand for technical instruction in London and throughout the provinces is very great, and the efforts that have been so far made by the City and Guilds of London Institute have been received with considerable satisfaction by artisans and others engaged in industrial pursuits, and promise, when further extended, to be of the utmost service in the development of technical education in this country. Turning now more particularly to the progress and the applications of science, I venture to make mention of a few topics which have come under my own observation.

(*To be continued.*)

OUR ASTRONOMICAL COLUMN

LUNAR ECLIPSES, 1880-84.—The total eclipse of the moon is only partly visible in this country, the middle occurring at 3h. 39m. Greenwich time, and the moon not rising until seven minutes later; the end of the total phase takes place at 4h. 24m., and the last contact with the earth's shadow at 5h. 33m. In Australia the whole eclipse may be witnessed to advantage. On December 5, 1881, there will occur an almost total eclipse (magnitude 0·97), again only partly visible here; the first contact with the shadow at 3h. 28m., and the moon rising at 3h. 50m.; greatest phase at 5h. 8m. In 1882 there will be no lunar eclipse. On October 16, 1883, a partial eclipse is barely visible here; first contact with the shadow at 5h. 59m. a.m., the moon setting at 6h. 25m. The next favourably-circumstanced lunar eclipse, as regards observation in this country, will take place on the evening of October 4, 1884; first contact with shadow at 8h. 15m., beginning of total phase at 9h. 16m., middle of the eclipse

at 10h. 2m., ending of total phase at 10h. 48m., and last contact with shadow at 11h. 49m.

A PROBABLE VARIABLE STAR.—On November 25 Swift's comet was compared with the star No. 4339 of Lalande, by Mr. Talmage at Mr. Barclay's Observatory, Leyton, the magnitude of the star being estimated 8, as it was also by Lalande. Argelander, in the *Durchmusterung*, gives it 6·4, and Heis made it a naked-eye star (6·7), but errroneously identifies it with Lalande 4359. It escaped observation in the Bonn Zones, and may be worth occasional examination as likely to prove an addition to our variable star list.

FAYE'S COMET.—In the *Berliner atsronomisches Jahrbuch* for 1882, Prof. Axel Möller, of Lund, has given an ephemeris of Faye's comet extending to the end of March next. On comparing the theoretical intensity of light appended to the ephemeris with that corresponding to particular epochs in other appearances, it will be found that there is a probability of observing the comet for some weeks from this time without difficulty if the larger instruments be employed. Thus at the beginning of January the calculated degree of brightness is more than twice that appertaining to the dates when the comet was first and last observed with the Northumberland telescope at Cambridge, during the return of 1850-51, and the geocentric position is favourable for observation; a month later the intensity of light is still equal to that at the time of the first observation with the Copenhagen refractor in 1865, and even at the close of Prof. Axel-Möller's ephemeris it is equal to that at the first and last Cambridge observations above alluded to; the comet's place, however, will then be drawing into the evening twilight. We have already remarked that the magnitude of the planetary perturbations of the comet's motion during the revolution 1873-1881 is greater than in any other revolution since the comet's discovery in 1843, and the success which has again attended his prediction of its apparent track in the heavens must have excited the admiration of those who have any experience or knowledge of such investigations, and the immense amount of skilled application involved in them.

SWIFT'S COMET.—The following elements depend upon Mr. Chandler's observation on October 25, one at Strassburg on November 9, and a third at Mr. J. G. Barclay's Observatory, Leyton, on November 25:—

Perihelion passage 1880, November 8·3691 Greenwich M.T.

Longitude of perihelion	42	15·2
,, ascending node	294	46·6
Inclination	7	21·3
Log. perihelion distance	0·04188	

Motion—direct.

The close resemblance to the orbit of the third comet of 1869, it will be seen, is maintained. The elements give these positions for Greenwich midnight:—

	R.A. h.	m.	Decl. °	′	Log. distance from Earth.	Sun.	$\frac{1}{r^2.\Delta^2}$
Dec. 2 ...	3	44·1	+50	57	9·3188	0·0680	16·8
3 ...	3	53·6	50	10			
4 ...	4	2·5	49	21	9·3366	0·0721	15·2
5 ...	4	10·7	48	32			
6 ...	4	18·5	47	41	9·3556	0·0765	13·7
7 ...	4	25·6	46	50			
8 ...	4	32·3	+45	59	9·3756	0·0811	12·2

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—No further regulations have been issued by the University Commissioners for the Professoriate. Opinion is much divided in the University itself as to the operation of the new rules. There have been several memorials to the Commissioners got up, some praying that no alterations be made, others approving the new Councils of the Faculties. There seems to be a general feeling against insisting on the professors examining their classes every term, and against making attendance at their lectures compulsory. The Councils of Faculties are regarded by many with favour as a means of bringing the tutors and lecturers of the various colleges who are engaged in teaching the same branch of learning into closer relationship, and enabling them better to divide the work among them.

At Balliol College an extra scholarship on the Brakenbury Foundation has been awarded to Mr. A. D. Hall of Manchester Grammar School, for Natural Science.

A MEETING of the Convocation of Victoria University was held at Owens College, Manchester, on Friday, Dr. Greenwood presiding. A resolution was received from the Associates of the College expressing their gratification at the creation of the University, and pledging themselves to perform their part in maintaining the welfare, dignity, and fame of the University, and promoting its objects. Standing orders for the regulation of the proceedings of Convocation were adopted, and the Rev. C. J. Poynting was appointed clerk.

THE recently-presented budget of Prussia shows that, despite the financial straits of the kingdom, no considerations of economy are allowed to hamper the growth of its scientific and educational system. First on the list come the nine universities with an allotment of 7,050,000 marks (352,500*l*.). Berlin receives the lion's share, 1,378,348 marks, an increase of about 37,000 marks on its last annual subvention. Bonn and Königsberg each have 740,000 marks, Breslau 600,000, Kiel 404,000, Marburg and Halle each 430,000, Göttingen 201,000, and Greifswald 136,000. Of the above-mentioned sum about 1,306,000 marks are appropriated for extraordinary expenses in connection with the construction of university buildings, and of this amount Berlin absorbs over one-half, viz., 766,000 marks. The other chief items in the Budget of Public Instruction are: Gymnasia and Realschulen, 5,000,000 marks; primary schools, 14,500,000; orphanages, schools for the blind, deaf and dumb, &c., 300,000; technical schools, and for the general furtherance of science and art, 3,000,000 marks.

THE number of pupils of Lycées and Colleges in the French Republic is 87,000 (46,500 for Lycées and 40,500 for Colleges). Last year it was only 84,700. These establishments may be considered as analogous to the English grammar-schools.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, November.—The metric system: is it wise to introduce it into our machine-shops? by C. Sellers.—The weakening of steam boilers by cutting holes in the shell for domes and necks, by W. B. Le Van.—Observations in Brazil, by W. M. Roberts.

Rivista Scientifico-Industriale, October 31.—*Résumé* of solar observations at Palermo Observatory in the third quarter of 1880, by Prof. Ricco.—Experimental researches on the action of light on transpiration of plants, by Dr. Comes.—Dynamometric break with circulation of water, by Prof. Ricco.

Journal de Physique, November.—On the combination of phosphuretted hydrogen with hydrochloric acid, by M. Ogier.—An amplifying barometer, by M. Debrun.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 18.—Robt. McLachlan, F.R.S., in the chair.—Dr. Geo. E. Dobson exhibited a remarkable parasitic worm from the intestine of *Megaderma frons*, from the Gold Coast. It appears allied to *Pterygodermatites plagiostoma*, Wedl, from the Long-eared Hedgehog, though on first hasty examination he (Dr. Dobson) had been disposed to regard it as a new genus, *Metabdella*. Dr. McDonald further drew attention to its peculiar anatomical structure and relationships. Dr. Cobbold agreed to the importance of the observations as verifying previous discoveries, with addition of novel structural details. He considered the worm as identical with the *Ophiostomum* of Rudolphi and Willemoes Suhm, with *Pterygodermatitis* of Wedl, and with *Rictularia* of Froelich, and he regarded it as an aberrant member of the Ophiostomidæ, whereas Wedl thought it came nearest the Cheiracanthidea.—Dr. Cobbold also exhibited specimens of *Distoma crassum*, Busk (previously in 1875 shown to the Society), from a Chinese missionary who, on return to China with his wife and daughter, were again all attacked by the parasite, and obliged to return to England.—A paper was read on a proliferous condition of *Verbascum nigrum*, by the Rev. G. Henslow. The upper part was very diffuse with leafy axes produced from the centres of the flowers, while the lower part had flowers with very large ovaries adherent within to arrested proliferous branches. These differences may be attributed to the general tendency of

the sap to run to the extremities and thus cause an excess of development above with simultaneous arrested condition below.—A paper on the classification of the Gasteropoda (part 2) was read by Dr. J. Dennis McDonald. In this communication the author gives further data in support of his mode of arranging the group dependent on anatomical characters.—"Novitates Capenses" was the title of a paper by Messrs. P. MacOwan and H. Bolus, in which, among other novelties described of South African plants, were *Ranunculus Baurii*, *Ericinella passerinoides*, *Orthosiphon ambiguens*, and *Harpolirion capensis*, the last a representative of a form hitherto known only from Australia.—A communication from the Rev. M. J. Berkeley, on Australian fungi (part 2), principally received from Baron F. von Müller, was taken as read.—Lieut.-Col. H. Godwin-Austin was elected a Fellow of the Society.

Entomological Society, November 3.—Sir Jno. Lubbock, Bart., vice-president, in the chair.—Mr. E. Meyrick of Hungerford, Wilts, and Capt. Thos. Broun of Auckland, New Zealand, were elected as Ordinary Members, and Dr. J. E. Brandt, president of the Russian Entomological Society, was elected as a Foreign Member of the Society.—Mr. Waterhouse exhibited, on behalf of Mr. Sydney Olliffe, a pair of dwarfed specimens of *Epione vespertaria*, taken at Arundel.—Mr. McLachlan exhibited some curious galls on a broad-leaved *Eucalyptus* from Australia, which were stated to be made by a lepidopterous larva, and also mentioned that in a letter he had received from Mr. Rutherford, dated from Camarcons, West Africa, the writer stated that he had taken *Papilio merope* and *Papilio cenea* in copula. Mr. Trimen doubted that the butterfly referred to by Mr. Rutherford was *P. cenea*, Stoll, which, to the best of his knowledge, was a form of the female confined to South Africa, and was more probably either *Hippocoon*, Fab., or one of the other prevalent West African forms.—Prof. Westwood exhibited a globular gall on the surface of a sallow leaf made by a species of *Tenthredinidæ*, and also a dipterous larva (Syrphus) found closely adhering to the stem of a pelargonium.—Mr. Kirby exhibited a remarkable variety of *Epunda lutulenta*, and also a remarkable form of *Apatura*, stated to have been taken by Mr. Ralfe in Pinner Wood.—Sir Jno. Lubbock exhibited some interesting larvæ which Mr. Culvert had forwarded to him from the Troad through Sir Joseph Hooker. He stated that these larvæ had recently appeared there in great numbers, and were likely to prove most useful, as they fed on the eggs of locusts. These larvæ were probably coleopterous, and Sir Jno. Lubbock suggested that if the species does not exist in Cyprus it might be worth while to introduce it there.—Mr. Trimen exhibited a wingless female specimen of the Hymenoptera, which he had strong grounds for believing was the female of the well-known *Dorylus helvolus*, Linn.—Mr. Trimen also exhibited six cases fabricated by a South African lepidopterous larva, of which the outer covering consisted of particles of sand and fragments of stone, which gave them a most peculiar aspect, resembling in general appearance a myriapod.—Sir Sydney Saunders read a paper on the habits and affinities of the hymenopterous genus *Scleroderma*, with descriptions of new species.—Mr. Edward Saunders read a paper entitled a synopsis of British *Heterogyna* and fossorial *Hymenoptera*.—Prof. Westwood read a paper containing descriptions of new species of exotic diptera, with a supplement containing descriptions of species formerly described by the author in somewhat inaccessible publications.

PARIS

Academy of Sciences, November 15.—M. Edm. Becquerel in the chair.—Researches in isomerism, benzine, and dipropargyl, by MM. Berthelot and Ogier.—On papaïne; new contribution to the study of soluble ferments, by M. Wurtz. In one experiment 0·05 gr. of papaïne fluidified about two thousand times its weight of moist fibrine. It seems that it begins by fixing on the fibrine, and the insoluble product gives, by action of water, soluble products of hydratation of fibrine, while the ferment, becoming free again, may act on a new portion of fibrine. The action is thus related to that of chemical agents, *e.g.* sulphuric acid.—Enrichment of plumbic earths by a current of compressed air, by M. Delesse. The apparatus, called *trieur à soufflet*, effects a sorting of pulverulent matters, which cannot be separated by water. Earths of very fine grain cannot well be treated with it, and unfortunately it is they that contain most lead. The lead-dust produced is unhealthy for the workmen.—Observations of M. de Quatrefages on the Marquis de Nadaillac's work, "Les premiers Hommes et les Temps préhistoriques." M. de Quatrefages thinks that man probably existed in Portugal in the Tertiary epoch.—Observations on the publication of Dr. Guérin's works, by M. de Quatrefages.—On the arrangement of the cervical vertebræ in the Chelonians, by M. Vaillant.—Experimental researches on the heat of man during movement, by M. Bonnal. *Inter alia*, all muscular exercise raises the rectal temperature. The increase is not directly related either to duration of the exercise or to apparent fatigue. The altitude, state of the atmosphere, energy of movements, and nature of clothing affect the increase. All rapid exercise diminishes the peripheral temperature (in mouth, armpit, or groin). The rectal heat may reach 39·5°. In rapid climbing it is in the first half hour that the rectal temperature is most raised, it may then become stationary or fall. In general, a rigorous application of the laws of mechanics to the human system is not warranted.—Studies on the habits of phylloxera during August to November 1880, by M. Fabre. The young insects showed (in the author's experiments) a strong liking for light. The present year seems very unfavourable to the parasite.—On some linear differential equations, by M. Brioschi.—On the equilibrium of flexible and inextensible surfaces, by M. Lecornu.—On the compressibility of oxygen and the action of this gas on mercury when put in contact with it, by M. Amagat. Oxygen and mercury (pure and dry) he found to remain indefinitely long in contact without absorption. He operated at 50° and 100°, and with pressures from 110 to 420 atm. The compressibility of oxygen follows the laws he gave in his memoir of August 30. MM. Chevreul and Dumas made remarks on the subject.—On the liquefaction of ozone in presence of carbonic acid, and on its colour in the liquid state, by MM. Hautefeuille and Chappuis. Gradual compression of a mixture of ozonised oxygen and carbonic acid at − 23° gives a blue liquid of the same shade as the gas above. The products of decomposition of carbonic acid by the effluve are proved (by the blue colour on compressing) to contain a large proportion of ozone.—On malleable iron, by M. Forquignon. It seems to be intermediate between steel and grey pig-iron, differing from the latter by the special nature of its amorphous graphite and its greater tenacity; from steel, by its small elongations and its large proportion of graphite.—On the presence of phosphorus in the rocks of Brittany, by M. Lechartier.—On the composition of petroleums of the Caucasus, by MM. Schützenberger and Ionine.—On the temperatures of inflammation of gaseous mixtures, by MM. Mallard and Le Chatelier. Among other results, mixtures of protocarburetted hydrogen not only enter into slow combustion, but, when submitted to a certain temperature, may be inflamed after a variable time (which is longer the lower the temperature).—On the secondary wave of muscle, by M. Richet. A second contraction occurs, without fresh stimulation.—On the contagion of boils, by M. Trastour.—On the use of boring machines without use of explosive matter, by M. Biver. The advantages of Mr. Brunton's system are indicated.

CONTENTS